A SURVEY
OF
THE SCIENCE OF
PSYCHOLOGY

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By

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1933
THE PRINCIPIA PRESS, INC.
BLOOMINGTON, INDIANA

C. E. Pauley & Co., Inc.
Printers

TO

MY BROTHERS

PREFACE

The present volume offers to students an exposition of organismic or interactional psychology. It is not, however, a simplified version of my *Principles of Psychology,* but a new work altogether.

In this book it has been my aim to lay before the college student or general reader the materials of psychology not as firmly settled facts and principles but as problems to be faced and worked over. This aim, I hold, does not commit the writer to a hodge-podge of indiscriminate views. I believe a student in psychology may be allowed the guidance of a viewpoint, and at the same time trusted to discover for himself how well it comports with facts.

Were it possible to disregard established belief and tradition, the proper method for the psychologist would be to proceed to the description of psychological phenomena without regard to the competing conceptions current in the psychological field today. Unfortunately this is not feasible. The student of psychology who turns to the literature of the subject inevitably discovers that psychological phenomena are differently interpreted. For this reason I must refer to other psychological conceptions. It is my purpose, however, to reduce to a minimum the polemical character of the exposition. Accordingly, traditional viewpoints will be discussed only in order to throw into relief the interactional or organismic conception.

It may be well to state some of the assumptions of the organismic viewpoint. One of the first is that psychology has its own subject-matter and is not a patchwork of physiology and philosophy as so many writers seem to believe. Organismic psychology holds that psychological phenomena are very specific interactions between organisms and stimulating objects.

The interaction view, it is submitted, allows the student to look upon psychological phenomena (remembering, reasoning, etc.,) as objective, natural happenings. On the other hand, the psychologist is relieved from the necessity of reducing his data to actual or hypothetical, neural or general biological events—or worse still, inventing physiological facts to explain psychological phenomena. To do either results in a serious misinterpretation of psychological data.

Psychological phenomena are, of course, always at the same time biological phenomena. In other words, physiological activities

always participate in psychological happenings. It is an advantage of the organismic viewpoint that it can treat the biological facts implicated in psychological phenomena in an unbiased manner. And so the reader will find a number of chapters (21-25) devoted to man as a biological organism.

Another assumption. It is no longer necessary in order to make psychology scientific to restrict our descriptions to comparatively simple activities (reflexes or habits) as the objective psychologist has been doing. We may then quite properly discuss such behavior as imagery and voluntary action. Furthermore, we may take account of the social and cultural influences upon our mentality. This we do in the concluding chapters (26, 27) devoted to the psychological individual as an anthropological being.

Wherever possible I have attempted to indicate the experimental treatment of the various topics. I want to point out expressly, however, that the laboratory studies described in this book are not intended to mislead the student into thinking that all or even a large part of psychological phenomena have been subjected to experimental handling, but rather to give him an idea concerning laboratory work in psychology.

The attention of the reader is also called to the purposes governing the selection of references at the end of the book. These are (1) to furnish a literary survey of what psychologists are doing, irrespective of their viewpoints, (2) to offer the most readily available materials, hence the predominance of English references, and (3) to give preference to items containing citations that will help the student further to pursue his interests in special phases of psychology.

I wish to thank a number of my colleagues in the fields of both psychology and biology, who have been kind enough to read the manuscript of this book in whole or part. Among these I should like to mention Professors J. A. Badertscher, P. M. Harmon, G. W. D. Hamlett, W. F. Book, R. C. Davis, W. N. Kellogg, and C. M. Loutitt. To those whose suggestions have helped to make a less faulty volume than would otherwise have been the case I am especially grateful.

Also, I am deeply indebted to Doctor Harold D. Rose for his efficient work on proofs and index; to Professor J. H. Russell of Miami University for various favors arising out of his use of a mimeographed edition of this work; and to H. R. Kantor for invaluable assistance rendered throughout the entire development of the book.

May, 1933.

ACKNOWLEDGMENTS

Except in the cases of original figures and those which are in such general use as not to require special identification, the writer has indicated the original sources of illustrations in the attached legends. He wishes to take this opportunity to thank the following persons and firms who have been kind enough to grant their permission to use figures from their books.

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In addition, the author wishes to thank Mr. Archie Warner for his help in drawing illustrations.

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CHAPTER I

WHAT THE PSYCHOLOGIST STUDIES

The Subject Matter of Psychology

Everybody knows that psychology is the study of such activities as seeing, hearing, feeling, imagining, remembering, thinking, and desiring. It is also common knowledge that whenever a person performs psychological activity he is interacting with something. You do not see or hear unless you see an object or hear some kind of sound. You are not planning unless you plan a vacation or some other activity.

These things to which one responds or with which one interacts are conventionally called stimuli.[1] Such stimuli elicit or incite the organism's behavior. Since all psychological events consist of just such interactions of organisms and stimulus objects, we may therefore define psychology as the study of the interactions of organisms and things, or more exactly the interactions of responses and stimuli.

The Problem of Psychology

The mere isolation of subject matter, however, is only the first step in science. In addition, the scientist must understand the nature of the thing or event with which he deals, and the conditions under which it operates. This process of understanding one's material involves *definition, analysis,* and *interpretation.*

Scientific *definition* means pointing out the essential differences between a certain kind of fact, and other similar and dissimilar phenomena. Thus the student of psychology must, for example, know how psychological phenomena differ from physical and biological facts. Furthermore, he must know how to identify each of the particular psychological actions. He must know how a feeling response differs from a perceptual response and how each of these differs from other psychological events.

[1] **This term requires careful definition. Cf. pp. 22, 27 f.**

As to *analysis*. It is the essential problem of the psychologist to dissect a psychological event in order to discover the details of what actually happens on the part of both the reacting organism and the thing with which it interacts.

The *interpretation* of an event consists primarily of organizing separate facts into a definite system. Take the study of learning as an illustration. If we want to explain or interpret this psychological fact we must consider two kinds of factual organization. First, we must organize the details such as (1) the kinds of material to be learned, (2) the number of presentations; (3) the rate of acquisition, (4) the length of retention, etc. Secondly, to explain learning, this whole series of details must be related to the conditions under which they occur. For learning depends upon (1) whether the person can see and hear well, (2) whether he is fresh or fatigued, (3) whether the present material is related to what the person already knows, and (4) whether or not he is interested in it.

These three phases of scientific investigation—namely, *definition*, *analysis*, and *interpretation*—will motivate our studies throughout this book.

How Psychological Facts Differ from Other Natural Phenomena

Psychology, like physics, astronomy, or biology, is a natural science. Each of these sciences studies the interaction of things. It is necessary therefore to find out the differences between psychological and other interactions. There are two reasons for this necessity. In the first place, as we have seen, it is by this means that we achieve an understanding of our subject-matter. Another reason is that the psychological organism is always at the same time also a biological organism and a physical thing. Accordingly, when the organism perceives or remembers we must know just how such psychological events differ from the physical act of dropping to earth from an airplane, and from the organism's biological action of assimilating food. Each of these types of phenomena displays vital differences in essential details.

Physical Interactions are Commutative.—Inanimate interactions are comparatively so simple that the physicist describes them in terms of an equivalence of forces. In everyday language we can

say that these forces are twins. A in Fig. 1 cannot push on B unless B at the same time pushes on A. Accordingly, when physical objects interact, the result is merely an interchange of energy. Thus the interaction between two billiard balls is expressed in Newton's third law that action and reaction are equal and opposite. When a per-

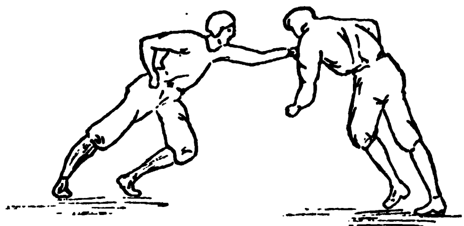


Fig. 1—Illustrating a physical interaction. What A does equals the action of B, according to Newton's third law. From Webster, Farnell, and Drew, *General Physics for Colleges,* The Century Co., publishers.

son falls out of an airplane his action possesses just such physical characteristics as we have been describing. We may regard the individual as a physical object gravitationally interacting with the earth as the other object. Because physical activity consists merely of this simple interchange of energy each object, when not in the process of interacting, is described as inert.

Biological Interactions are Responsive. Biological interactions cannot be regarded as simple interchanges of energy. An organism can expend a great deal more energy than is at the moment expended upon it. Because of the complexity of its composition, the biological object can store up energy which is released in comparatively large quantities. Thus what the plant turning toward the light does (Fig. 2) is entirely out of proportion to what the sun's rays do to it. The object with which an organism is in contact does not merely exert energy upon it, but stimulates it as well. The organism, on the other hand, is not merely acted upon, but responds. Consequently, biological interaction may be described as *responsive.* The formula for a biological event is not merely a mathematical equivalence $F = F$, as in the case of physical interactions, but can be indicated in terms of stimulus and response like this, $S \longrightarrow R$. Instead of being inert a biological organism is *irritable.* The stimulus calls out a response on the part of the

organism. We notice therefore that the action of the organism is predominant in the interaction.

Fig. 2—Illustrating a biological interaction. Radish plants phototropically responding positively toward light stimulus.

The way a biological organism acts can be accounted for by the exceedingly unstable character of its complex organization. It is constantly breaking down and building itself up. And so biological interactions are above all *preservative*. This is true both when the organism ingests food and assimilates it as part of its own structural organization, and when it is irritated by some foreign object and shrinks or moves away from it.

Because animal organisms, and especially the human being, are so predominantly psychological in their behavior, we can only observe them performing these biological interactions when we study such isolated behavior as the digestion of food. However, since even the human animal remains a biological organism until it develops a psychological behavior history, we can sometimes describe its behavior entirely in terms of biological stimulus and response. This is the case of the infant before birth.[2]

Psychological Interactions are Adjustive.—Since biological actions constitute primarily maintenance behavior, they are constant in their operation. No matter how frequently the organism is stimulated to respond, the pattern of these activities is the same. This follows, of course, from the fact that the behavior of biological organisms is the mere operation of a set of fixed structures. Not so the psychological interaction. The latter is more

[2] But see Chap. 3, pp. 45 f.

flexible. For example, in reacting to a book I can either walk or run to get it, or even ask someone to get it for me. This fact is still better observed in the constantly changing poses of fencers. (See Fig. 3.) Through their increasing contacts with the same

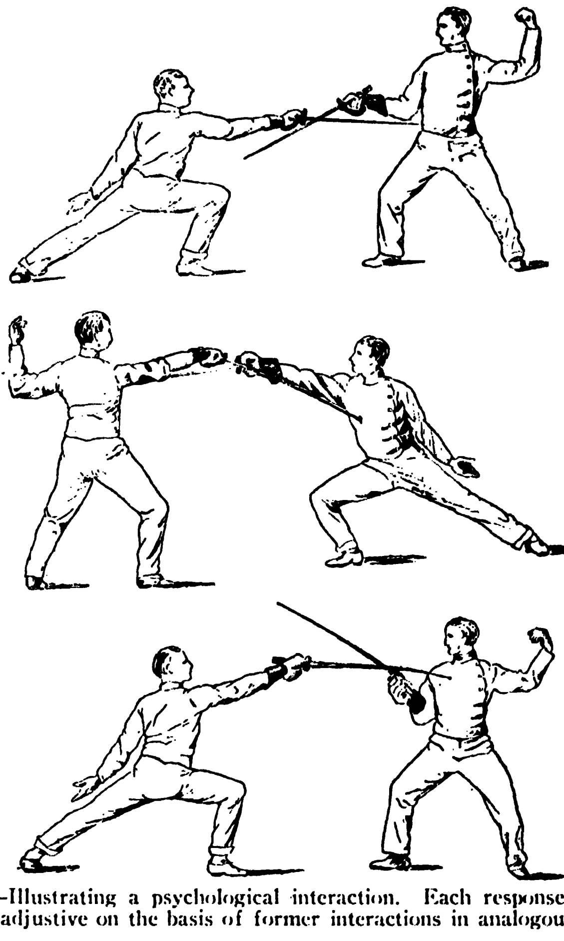


Fig. 3—Illustrating a psychological interaction. Each response of A and B is mutually adjustive on the basis of former interactions in analogous situations.

things psychological organisms can build up many different reactions to them. Thus they can interact more intimately and more independently with objects than is the case with merely biological organisms. For this reason we may regard psychological interactions as *spontaneous* and *historical.*

Psychological adjustments are likewise *explorative, manipulative,* and *orientative.* Each of these modes of interaction suggests a form of reactional spontaneity. The psychological organism does not merely come into contact with the objects of its surroundings, but it seeks contact with them, or in other words explores its surroundings. Again, the psychological interaction is not sheerly preservative but manipulative as well. When the child breaks open his rattles to see what is inside them he changes the things with which he interacts without making them a part of himself. These manipulative activities may of course be constructive as well as destructive. And finally, psychological interactions are orientative.[3] The organism may take account of likenesses or differences of things, or it may become pleased or displeased by them, and in this way take attitudes toward the objects in its environment.

Special Characteristics of Psychological Phenomena

So far we have been attempting to characterize psychological phenomena as they compare with the data of other sciences. We have pointed out the essential differences between psychological behavior and the behavior of biological organisms and physical objects. Now we must describe psychological phenomena as they exist and operate by themselves. We may sum up the characteristics of psychological interactions in the following six propositions:

1. Psychological interactions are differential
2. Psychological interactions are integrative
3. Psychological interactions are variable
4. Psychological interactions are modifiable
5. Psychological interactions are delayable
6. Psychological interactions are inhibitive

Psychological Interactions are Differential.—The interaction of an individual with a stone is different from his interaction with a tree. We may say he discriminates between the two objects. A fundamental characteristic therefore of psychological interactions is their specificity. Each reaction is definitely correlated with a stimulating function of an object and, conversely, each different

[3] The term orientation is used here in a popular sense. Orientation in a strict psychological sense is knowing, see Chap 12.

stimulus function of an object elicits a different response. Of necessity then, different objects, each with a different stimulus function, elicit different responses in the organism. In addition, different stimulus functions of the same object produce varying behavior effects upon the organism. The tree may stimulate me to admire it, climb it, or fell it. All this because the organism has passed through different behavior experiences with objects. It is precisely through these behavior contacts that objects take on different stimulating functions for different individuals. The young child discovers that a stone is not only something to be dodged, but an object that can be thrown too. Frequently the different stimulus functions of an object may be connected with different organizations of its qualities. For example, the child reacts to an orange as an edible thing because of its edible properties, whereas it is a ball for him on account of its size, shape, and weight.

This extreme differentiability of psychological interactions indicates clearly that the organism is not only sensitive to things as wholes, but differentiates their colors, tastes, odors, textures, hardnesses, etc. This differentiation extends also to the settings or auspices of things. A blue book on a white cloth calls out a different response from that initiated by the same object on a black cloth.

Psychological Interactions are Integrative.—Observe how the child learns to write. At first he makes only small single strokes; then these actions are integrated to produce letters as units. The letters in turn are organized into words. And finally word-producing actions become integrated into sentence-making action units.

This integrational effect can be appreciated perfectly by anyone who has learned to typewrite. The first action-units consist of striking the separate keys. These become organized into word and later into phrase-making behavior units. In the same way all of the complex behavior of the mature organism has been integrated from simpler responses in the course of the individual's behavior history.

The effect of integration, of course, is not limited merely to the response phase of the interaction. The same summation process takes place on the side of the object. Corresponding to the organization of responses, the units of the copy material become fused into larger units. This means that whereas in the early stage of

learning to typewrite each separate letter (t-h-e) stimulates an individual response, in the later periods the whole word as a single unit (the) elicits a single integrated reaction. The practiced typist develops exceedingly complicated integrations of this sort. On the whole, the integrational principle symbolizes the exceedingly close interconnection between the organism and the things with which it interacts.

Integration is supplementary to differentiation. When we differentiate we analyze objects and separate them off on the basis of their qualities. On the other hand, when we integrate we organize the qualities of things into units, and series of things into still larger units.

Psychological Interactions are Variable.—Put a hungry cat in a cage near which is placed a piece of fish and notice its attempts to reach the food. As long as the animal is in contact with the stimulating object it will persistently vary its behavior until it succeeds in getting at the fish. Meanwhile it performs an infinite variety of acts, pulling, pushing, biting, squeezing, and shaking the objects that prevent it from reaching the food. These actions have all been observed in experiments which Thorndike performed on various animals.[4]

How variable can the interactions be between the organism and the stimulus object? The answer is that the amount of such variability depends upon the number of specific stimulus and response connections which have already been built up during the animal's present and past contacts with the object in question. When such stimulus and response connections are very numerous the organism may continue to respond until it succeeds in attaining its goal, or becomes fatigued and exhausted.

Psychological Interactions are Modifiable.—The burnt child dreads the flame. This maxim excellently points out a striking and important principle of psychological interaction. The child who burns his finger by sticking it into the flame so modifies his later behavior that he does not undergo again the same painful result. In everyday language we say that he profits by his past experience.

[4] Thorndike, Animal Intelligence, Macmillan, 1911.

The modification of the interaction consists of the organism acquiring a new and often a more effective way of reacting to the object, while the object correspondingly takes on a new kind of stimulus function. The candle now has the function of eliciting a finger-withdrawing response instead of the finger-projecting, pain-producing reaction.

We can sum up the principle of modifiability by saying that the successive contacts of an organism with objects culminate in the development of new modes of interaction based on the results or conditions of prior contacts.

Psychological Interactions are Delayable.—When I ask you to meet me tomorrow at ten o'clock I stimulate you to start an action which will not be completed until the stipulated time. The fundamental principle here is that the individual is in contact with an object which incites him to an action which is not completed until a certain time interval has elapsed. Such delays in consummating interactions account for a great deal of the spontaneity of psychological behavior.

Psychological Interactions are Inhibitive.—You are asked to attend a theatre party. If this is the thing you would most like to do one would expect your answer to be yes. As it happens, however, an examination has been announced for tomorrow; so your affirmative reaction is checked. Instead of saying "yes," you decline the engagement. This is a good example of an inhibited interaction. Because the psychological organism is capable of performing numerous kinds of responses, he can, when circumstances dictate or warrant, substitute one type of action for another.

These six characteristics of psychological interactions are the fundamental marks which differentiate psychological from other kinds of phenomena. When the interactions of organisms and things around them answer to these descriptions they are psychological; if not they belong to a different branch of science. We must add, however, that not always do we necessarily observe all of these characteristics in every single psychological interaction. Taken all in all, however, they constitute a workable set of criteria.

Divisions of Psychological Study

It is only natural that within the psychological domain some phenomena differ markedly in detail from others. Psychology,

therefore, like the other sciences, has to be divided into a number of departments or specialities. In the following list we mention some of the more prominent specializations.

(1) Animal psychology
(2) Child psychology
(3) Social psychology
(4) Abnormal psychology
(5) General psychology

ANIMAL PSYCHOLOGY.—All animals as distinguished from plants belong to a single biological series. This animal series, of course, includes man as well as subhuman or infrahuman organisms. Now it is to be expected that animals below man on the evolutionary scale are only able to perform actions which are far simpler than those performed by man. This fact gives rise to a distinct branch of psychological investigation. Accordingly animal studies have been designed to solve such problems as whether cats, chickens, dogs, monkeys, and other animals can discriminate colors, sounds, and shapes. But perhaps the most important investigations have been those concerned with the capacities of animals to learn and how this learning takes place.

Because there are few kinds of human behavior that are not also performed by infrahuman animals, animal psychology is to a great extent a comparative science. From the investigation of infrahuman animals we learn a great deal concerning the likenesses and differences between human and subhuman organisms. There is no doubt but that knowledge obtained from the study of infrahuman animal reactions can be used to throw light on the way human organisms interact with their surroundings. One of the greatest values of animal psychology is that one can experiment on animals in ways that are not convenient or possible with the human organism. It was through such experiments that psychologists have recently obtained a great deal of knowledge concerning the function of the brain in learning.

CHILD PSYCHOLOGY.—The innumerable problems involved in the care and training of children elevate the psychological study of infancy and childhood to an extremely high place in psychological science. Since psychological phenomena are events that originate

in the behavior histories of individuals the genetic study of infant behavior is of the greatest importance.

The earliest careful studies of child behavior were biographical. Nurses simply recorded the developmental details of individual children. Somewhat later, physicians and psychologists compiled a great many facts concerning the behavior of infants. These workers were interested in collecting statistics concerning the first appearance of certain reflexes, the early color preferences, etc.

About a decade ago, Watson initiated a movement for the experimental study of infants from the very first days of birth.[5] This movement is rapidly expanding and there are now available numerous, minute studies of the systematic development of newly born infants.

A distinct branch of child psychology has been cultivated in connection with the schools. It was Binet's interest in the learning capacity of children that led to his formulation of mental tests and the development of the test movement.

Social Psychology.—Most of our behavior is conventional. Consider language. The words we use are English and not French or German. Thus we are conditioned by the community of persons among whom we live. But this is not all. Even the things we talk about and the conditions under which we say what we do are likewise conventional. Conventional or cultural conduct then is the subject-matter of social psychology.

The importance of social psychology lies precisely in the fact that most of our behavior is acquired in a prescribed way, and performed through definite contacts with specific groups of individuals. The social psychologist isolates the great mass of our conventional actions such as shared beliefs, manners, and knowledge, and contrasts them with the behavior we acquire as private individuals.

Abnormal Psychology.—At the basis of all psychological phenomena lies the principle of individual differences. When psychological interactions are studied in their minute details it is discovered that no two persons ever perform what we call the same action in

[5] Gerver, in his biographical sketch of Bechterev, says that that scientist established long before this date an institute for this purpose. See Bechterev, General Principles of Human Reflexology, International, 1932.

the same way. Such specificity of performance may become so exaggerated as to constitute a striking variation. For example, most people remember things with a serviceable amount of detail. On the other hand, an individual may not be able to remember even the essentials of a situation, or he may react to past situations in such enormous detail that the response hinders rather than helps him in his human adaptations.

Behavior differences may be so great as to mark certain individuals as totally abnormal personalities. Among such are the idiots, who have never acquired sufficient behavior equipment, the manic-depressives and epileptics, whose behavior shows marked, periodic disintegration, and the paretics, whose whole behavior equipment undergoes rapid and inevitable degeneration.

These gross differences in psychological performances are samples of a large number of extreme variations in human conduct. It is such abnormal reactions and personalities that provide the study materials for specialists in abnormal psychology.

General Psychology.—Underlying all these divisions of psychology are the general principles of psychological behavior that do not necessarily refer to any particular specialized branch. In the present book we confine ourselves to the study of these general facts. For purposes of illustrating normal, general, psychological principles we shall, however, find it expedient sometimes to refer to the data of the specialized branches of psychological study.

The Sources of Psychological Data

Sciences differ with respect to the sources of their data. Thus the physicist, chemist, and astronomer study phenomena far removed from their own activities. The astronomer in many cases studies the interactions of things taking place thousands of light years from the earth. The physicist, of course, can study the human organism as a physical thing, but he would gain very little scientific information in this way. For the most part physics has to do with the behavior of such things as levers, dynamos, and engines. The chemist who specializes in the biochemical branch comes closer to human sources of facts than the physicist, for the former derives a great deal of study material from the human organism. But biochemistry is after all a small part of the total science of chemistry.

When we turn to the biological sciences a different situation prevails. In these disciplines the investigator finds in his own structure and conduct a profuse source of scientific material. As a matter of fact the requirements of medicine have influenced the biologist to make human anatomy and physiology the most prominent of all the biological specialties.

Psychology, however, more than any other science, finds its attention directed to man and his activities as the primary source of psychological data. We can easily understand this in view of the fact that the data of human psychology are by far the most complex and on the whole the most interesting.

The psychologist therefore goes further than any other scientist in studying facts close to home. Whereas other scientists study things increasingly different from themselves, the psychologist frequently finds it much easier to gather information by investigating his own activities rather than those even of other persons. When the psychologist studies his own feelings, judgments, memories, and ways of learning, he speaks of himself as utilizing an introspective source of data.

The Methods of Psychology

Whether psychological facts are derived from a study of one's own responses or from those of other organisms there are two methods of garnering such data. These we may refer to as (1) field and (2) laboratory observation.

Field Observations.—For the most part psychological phenomena must be studied just as they occur in nature. So intricate and intimate are the interactions of organisms and things, that they have to be studied just how and where they happen. This situation is not peculiar to psychology. Among the physical scientists the astronomer in particular is limited in this way. He cannot manipulate his comets and planets; he can introduce no changes in the motions of the heavenly bodies. The biologist, too, must to a great extent confine himself to field observations. The whole department of ecology constitutes a study of animals in biological contact with their environment.

Laboratory Observations.—The method of field observation has its decided limitations, however. It does not allow for a rigid

control of data. Accordingly, the psychologist wherever possible employs laboratory techniques for the more exact determination of his facts. At the present time it must be admitted, of course, that only the simplest forms of psychological action can be subjected to the rigorous manipulations of a laboratory. Instead of performing actual memory experiments we must confine our studies to the memorization of nonsense syllables and integers. Similarly, laboratory investigations of feelings and emotions must be restricted to simple behavior disturbances. But this situation does not indicate absolute experimental limitations. There is no principle involved in psychological science that suggests the permanent inability of the psychologist to experiment upon the most subtle and complicated of psychological interactions.

The Relation of Psychology to the Other Sciences

Although for purposes of investigation every scientist must isolate his data from that of the other sciences, it is obvious that this is only an investigative device. The facts in nature are all interrelated. We have already seen that every psychological activity is at the same time a biological and a physical fact. We may now add that many psychological activities, all the complex ones indeed, are likewise anthropological in character. Now this suggests the necessity for taking account of the interrelationship that exists between the different, scientific fields. Let us consider some of the points of connection between psychology and the other types of sciences.

PSYCHOLOGY AND PHYSICS.—Though psychological interactions are very different in detail from physical interactions they are subject to the same laws concerning the conservation and interchange of energy. This fact points to a common background in scientific law for the two sciences. Psychological events may be regarded as more complex and more inclusive than physical events, but the principle remains firmly established that no forces or powers can be introduced into psychological events if they are presumed to exist outside the bounds of actual space, time, and energy. Such is the abstract general relationship between the two fields.

Psychology and physics are related in a more practical cooperative manner. When an organism interacts with physical objects a complete knowledge of the event calls for an understanding of the

nature of such physical objects. The student of psychology is better equipped for his study when he commands a knowledge of the physical properties of the things that stimulate the psychological organism.

Furthermore, when the psychologist needs to construct apparatus his technical equipment is enhanced by a familiarity with the rudiments of chemical, mechanical, and electrical science. This fact has been strikingly demonstrated in recent years since psychologists have been making considerable use of vacuum tube apparatus for experimental purposes.[6]

Psychology and Biology.—Since the biological nature of the reacting organism must constantly be taken into account, psychology is very closely interrelated with biology. An understanding of the psychological interaction involves considerable knowledge concerning the organism's anatomical organization and physiological functions. At the very dawn of psychological science the workers in this field took it upon themselves to annex whatever knowledge was available concerning the nervous system. More recently the behavioristic interest has extended this connection with biology, and especially physiology, to include the operation of muscles and glands. Especially in the last two decades the increase of knowledge concerning the physiology of the glands and particularly the endocrines has stimulated contact between psychologists and biologists.

Psychology and Anthropology.—Because psychological phenomena are activities built up in the historical interconnection of the organism and its surroundings the specific human circumstances surrounding such interactions are of great importance. How the individual acts depends upon his civilizational or anthropological background. Especially our complex thinking, believing, and speaking reactions, as well as our manner and custom behavior, are conditioned by our contacts with cultural objects and events. It is necessary, therefore, that the psychologist should join intellectual forces with the anthropologist insofar as the latter is interested in human behavior.

[6] See, for example, Davis, A cathode ray oscillograph apparatus for the psychological laboratory, *J. Gen. Psych.*, 1931, 5, 107-115; also Davis and Porter, A measuring device for the galvanic reflex, *J. Gen. Psych.*, 1931, 5, 115-120.

Various Viewpoints in Psychology

Science always emerges from everyday knowledge. Under the most favorable conditions this popular knowledge is derived from actual observation of facts. To become scientific it requires only to be elaborated, tested, and critically formulated. But sometimes this common knowledge is mixed with traditions which do not represent things as they actually are. No science can be firmly established until these traditions are dropped. It has been the peculiar fate of psychological science to become involved with a great number of these popular traditions which are only gradually being rejected.

This circumstance appears to account for the fact that psychologists differ greatly in their description of essential facts. Whether or not this is the case it is certainly true that psychologists are not yet in complete agreement concerning the fundamental details of psychological phenomena. For instance, not all psychologists agree that the essential data of psychology are the interactions of organisms and things. Because the whole program of describing and interpreting psychological facts is conditioned by one's attitude toward the subject matter of psychology it is important that the student should be familiar with the various viewpoints. For this reason, we propose to describe briefly the three types of psychology that will best exhibit the differences in psychological conception—namely, (a) mentalism, (b) behaviorism, and (c) organismic psychology.

(*a*) MENTALISM.—The mentalistic viewpoint can be easily comprehended, since it coincides fairly closely with popular psychology. There are two distinct branches, the first of which is called functional or dynamic mentalism. It is concerned primarily with the description of the psychic phases of the actions of organisms. An example will clarify this conception. We observe that people jealously guard their own interests, sometimes to the disadvantage of others. Now this fact is popularly explained by asserting that there is a power in the individual variously named an "instinct of self preservation," an "acquisitive instinct," or an "instinct of self assertion." Notice then that the person's responses are presumed to be divided into two parts, first, the observable activities, and second, a psychic force or power which controls them.

In the same way, whenever the person feels, remembers, or thinks, his action is analyzed into mental states or processes connected with bodily action. The mental states, however, are not always presumed to cause or condition the bodily action. They are sometimes regarded as having been caused or intiated by the bodily action, or are supposed merely to accompany the latter.[7]

The second branch called structural or existential psychology is more concerned with the nature of the world than with actions of organisms, although the structural psychologist asserts that the mental nature of the world depends upon an organism. Mental phenomena are presumed to be the qualities of the world insofar as they depend upon the mind of man.

The structural psychologist assumes that it is his task to analyze the same things as the physicist does, but from a different standpoint. For example, take a musical chord. The physicist studies the vibration frequencies of the notes and the relation between them, while the psychologist studies the mental or sensation qualities (pitch, intensity, timbre) of each note and the way they are combined into the chord idea. These states of consciousness or psychic processes are all, of course, presumed to be correlated with bodily mechanisms, and especially the actions of the brain.

Mentalistic psychology is therefore dualistic. That is to say, it always presupposes that there is a mental element somehow connected with some non-mental factor. As we have seen, the functional branch assumes that an action always involves a mental and a biological phase, while in the structural branch the psychic or mental element exists alongside of some physical phenomenon. It is this dualism which occasions serious, scientific difficulties. When you ask the mentalist what is the fundamental difference between psychological actions or states and non-psychological things, his answer reduces itself to the proposition that the former do not exist in space. The subject-matter of psychology therefore is supposed to belong to an entirely different realm than that of the other sciences.

The mentalistic psychologist admits that in order to deal with such intangible and elusive materials a unique form of knowledge process is required, historically referred to as introspection. Since

[7] In the history of psychology this last idea bore the name of psychophysical parallelism, while the former two were called psychophysical interactionism.

one cannot observe anything that is transpatial, the objective observation employed in the other natural sciences had to be paralleled with the entirely new process of subjective observation.

But how can there be a science of unobservable things? Two answers are given. In the first place, it is said that psychic states are just as observable as anything else. Psychic states are asserted to be experiences, and everybody, it is said, can observe experience. To illustrate, when looking at a red ball the color, hardness, etc., which are separated out as the psychic factors as over against the light rays and other physical phenomena, are said to be experience. The mentalist declares that surely everybody experiences color sensations. But as a matter of fact, what the mentalistic psychologist calls psychic states are really the qualities which organisms discriminate in the things with which they interact. Thus sensations are only names for the colors, sounds, and other qualities of things. Calling these qualities experience does not make them psychic.

In the second place, it is asserted that consciousness or psychic processes can be studied through their manifestations. In other words, the mentalist says a psychic state is known through the effects it produces (the feeling of fear makes us run, the sensation of cold makes us shiver), or through the physiological happenings that accompany its operation (the nerve and muscle functions when one sees something).

(*b*) Behaviorism.—To a great extent behaviorism represents an attempt to overcome the difficulties of mentalistic psychology. The behaviorist declares that it is impossible for psychology to be a science as long as its subject-matter is transpatial and therefore unobservable. He argues that if the only thing you really can observe are the activities of the biological mechanism, then psychology is the science of the behavior of the biological organism. With this difference, however: The behavioristic psychologist studies the biological activities of the organism as a whole. Instead of investigating such partial functions as digestion, circulation, or respiration in the manner of the physiologist, the behaviorist proposes to study the total organism as it develops habits and performs learning reactions, and various other kinds of adjustments.

Beyond a doubt the behavioristic viewpoint is more scientific. We may accept it as an absolute axiom that there can be no science

unless it deals with observable phenomena. For this reason the whole conception of psychic manifestations has no place in a scientific system. But on the other hand, the question arises whether psychological phenomena can be reduced to the sheer functioning of biological mechanisms. We may be fairly certain that such activities as remembering, planning, or thinking can not be adequately described as the sheer operation of anatomical structures.

(*c*) ORGANISMIC PSYCHOLOGY.—Those who hold to the organismic view part company from both the mentalists and behaviorists. The organismic psychologist believes that the mentalistic conception of coordinate mental and bodily functions, and the resulting division between mind and body, are not based upon scientific observation. He believes that both of these conceptions are unwelcome remnants of old intellectual traditions.

On the other hand, the organismic psychologist cannot agree with the behaviorist in attempting to describe complex, psychological phenomena exclusively in terms of biological actions. The behavioristic viewpoint has the appearance of merely rejecting one of the two phases of psychic dualism. A serious difficulty in the work of the behaviorist is that he treats psychological phenomena as nothing but the immediate action of biological structures. In addition, he fails to consider that the nature and action of the stimulus object are as important features of the psychological event as the reacting organism. According to the behavioristic conception psychological interactions could only be responsive and not adjustive.

To be adjustive an interaction must be built up through an historical connection between the individual and the objects with which he interacts. It is only through the genetic building up of mutual interactions that the psychological event can take place. In fact, it is such interactional processes in their historical development that constitute the essential data of psychology. It is only such mutual interactions that can be properly called mental or psychological phenomena.

Take speech, for example. Is this action merely the operation of vocal structures as the behaviorist would have it? The organismic psychologist believes that the essentially psychological fact in speaking is that an individual has developed appropriate, linguistic re-

sponses to persons by building up a particular kind of speech behavior through the repeated interaction with those persons. The same thing is true of knowledge. The child knows how to multiply because he has previously interacted with the different combinations of the multiplication table. Knowledge of multiplication is just exercising these activities which he has acquired in this manner.

The nature of organismic psychology can be further understood by considering the problem of introspection. For the organismic psychologist the term introspection does not refer to a unique kind of scientific world, nor even a special method of knowledge. Rather, it merely means observing one's own interactions with things instead of some other person's. Just as the physiologist can observe his own changes in temperature, pulse rate, and metabolism, so the psychologist can study himself as he remembers, perceives, thinks, and feels.

Which of these three viewpoints shall we accept? If, as we believe, the organismic attitude accurately describes the facts of psychology without invoking any undesirable assumptions, it meets the criteria of a natural science. In this book then we shall describe psychological phenomena from the organismic standpoint.

CHAPTER II

THE ANALYSIS OF PSYCHOLOGICAL INTERACTIONS

Now that we have isolated and identified the subject-matter of psychology we are ready to analyze its details. We must work out the factors which constitute interactions between organisms and objects. This we can best accomplish by investigating five distinct topics as follows:

(1) The Segment of Behavior
(2) The Stimulus Function
(3) The Medium of Contact
(4) The Interactional Setting
(5) The Reaction System

The Segment of Behavior

The behavior life of an organism is absolutely continuous as long as the individual is alive. There is never a moment that it is not interacting with things. Psychological phenomena must be likened to a flowing stream, rather than to barbs set side by side on a wire. But this fact brings to the psychologist a serious problem, since the rigor of scientific description always demands the isolation of a distinct unit of observational fact.

To meet the demand we bring to our aid the conception of a behavior segment. If we think of the continuous activity of an organism as a line, then we may cut it into parts or segments. Each of the segments represents one of the simplest analyzable units of an interactional event. It consists of a single stimulus and its correlated response.

Stimuli and responses are reciprocal factors in a behavior segment. One cannot occur without the other. Probably the best way to describe a response is to say that it is something that the

organism does with respect to the stimulus object. The organism performs some action or movement. The stimulus, on the other hand, is an action or an operation performed upon the organism by the object with which it interacts. This stimulus action can be best defined as the evocation or the incitement of an action on the part of the organism. Thus the formula for every psychological interaction is:

$$S \longleftrightarrow R$$

Consider two individuals engaged in a sparring match. Each movement of A evokes a return action on the part of B. Each of A's movements then constitutes a stimulus for each action of B. Notice too that when A's action stimulates a response in B, B's movements or changes in posture serve as stimuli for other actions on the part of A. This is an effective illustration of behavior segments in which one person interacts with another individual.

A careful observation of the sparring situation will reward us with the discovery of an important psychological principle—namely, that we can divide off one segment of behavior from another by watching for the stimulus. When the stimulus consists of a definite action of A then we can fairly easily trace out B's response to this stimulus. Thus when we know the stimulus for action we can seize hold of the correlated response. In this way we are enabled to isolate particular behavior segments for our observation.

Responses and Reaction Systems.—To divide off a behavior segment into a stimulus and a response is only the beginning of our analysis. Because a response is almost always a complicated activity it is essential to analyze out the units of action of which it is composed. Consider the comparatively simple response of looking at a picture. Even such conduct is divisible into a series of action units. It involves postures, as when we assume and occupy a position in front of a picture, various turning movements to bring the object into visual focus, straining activities to get all the details, etc. When we succeed in singling out the very simplest action units composing a response we name them *reaction systems* and symbolize them rs. As we shall have occasion to see, reaction systems, as activities of a complex organism, are themselves not simple. As the very term implies, a reaction system is a complex behavior

fact, but it is the lowest analyzable integral action that the organism performs.

SIMPLE AND COMPLEX RESPONSES.—When we examine the various interactions of persons with the objects around them we find that sometimes they involve simple and at other times complex responses. The precise difference between these two types is entirely a matter of the number of reaction systems (units of action) contained in each. The simplest response is one that consists of only one reaction system. An example is the comparatively simple action of the person when he jerks his hand away from a hot object that he touches. In this case the hot object performs a single, unitary, stimulus function and the individual responds with a single reaction system.[1]

In other cases a single stimulus function calls out a response consisting of a series of reaction systems. For example, a sharp sound elicits a response involving the reaction systems of quickly turning in the direction of the sound, discriminating it as thunder, and finally settling down to what one was doing before. Whenever the response consists of more than a single reaction system we refer to it as a *response pattern.* The minimum number of reaction systems in a pattern of response is three—namely, (1) attending, (2) perceiving, and (3) performing a final action unit as shown in the accompanying diagram.

Simple Response

Stimulus ←——————→ Response
Hot object — Simple jerk (rs)

Complex Response

Stimulus ←——————→ Response
Loud sound — Attending (rs) | Perceiving (rs) | Final act (rs)

TYPES OF RESPONSE PATTERNS.—All response patterns we have learned consist of sequences of movements, postures, secretory changes, verbal and other reaction systems. But these action units

[1] As a rule stimuli consisting of natural properties of things usually call out simple responses.

are not always organized in the same way. Each combination of reaction systems, therefore, constitutes a different type of response pattern.

(1) Precurrent and Final Response Patterns.—Consider the reaction-time experiment in Fig. 4.[2] Since the total interaction here consists of performing a particular response to a given signal, the activity is finished when the key is released. This key-releasing action constitutes the end or final act of the response. It concludes the particular interaction of the person and the stimulus object.

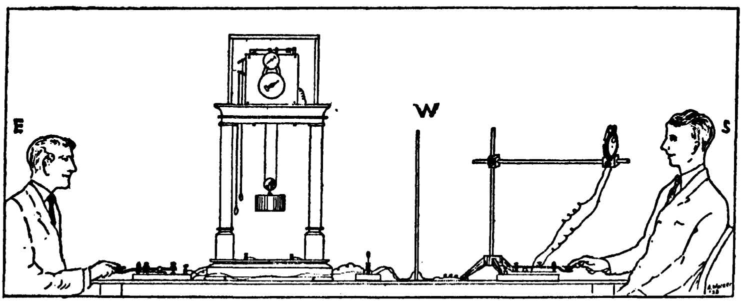


Fig. 4—The reaction-time experiment. The experimenter E presses a telegraph key producing a click sound and at the same time starting the Hipp chronoscope which measures time in thousandths of a second (milliseconds). The subject S responds by releasing the key which stops the chronoscope, from the dial of which E records the time consumed. The Hipp chronoscope is only one of several time-measuring instruments. The same technique can be used for visual touch, word, or electrical shock stimulation, and the response may be verbal as well as finger action. In the former case the circuit is broken by means of a voice key, a circular membrane (shown in illustration) which vibrates to sound. W is a screen between reactor and experimenter.

Before this can happen, however, the person had to perceive or differentiate the stimulus—for example, hear the sound or see the color. We call this the perceptual reaction system. Now because the seeing or hearing act must precede the releasing act we call it a *precurrent reaction system.* But this is not all. The hearing or seeing precurrent act depends upon another act which in turn precedes it. Namely, the person must prepare to see or hear, he must get set for the signal. And so we have another indispensable pre-

[2] For a more elaborate description of the reaction-time experiment see Valentine, Readings in Experimental Psychology, Harpers, 1931, Section 1.

current act. We call this the attention act. The simplest response pattern then contains at least two precurrent reaction systems.

Stimulus ←——————→ Response

Visual or auditory signal	1st precurrent reaction system (getting set)	2nd precurrent reaction system (seeing or discriminating signal)	Final act (releasing key)

As we might expect, the more complicated response pattern includes in the precurrent phase a number of other preparatory actions in addition to the attending and perceiving reaction systems. In order to take down the map from yonder wall I must not only attend to it, see it, but also get up from my seat, walk around the table, and approach the wall where the map hangs in order finally to unhook it from its hanger.

(2) Central and By-Play Response Patterns.—The three reaction systems (attending, perceiving, finger-raising) constituting the pattern of the reaction-time response we may regard as central adjustments. The term central means that the activities are all a very definite part of an adaptation or adjustment. Now in perhaps every case the action units of the central type are correlated with others which are not so definitely adjustmental in character. It is these that we call by-play reactions. To illustrate, while the person is attending to the source of the signal he may say to himself, "this is my best effort," or "I hope nothing will interfere with my seeing (or hearing) the signal." The diagram of our response pattern will then be complicated as follows:

Stimulus ←——————→ Response

Visual or auditory signal

Consisting of

1. Central Response Pattern (attending, perceiving, pressing key)
2. By-Play Response Pattern (verbal reactions, affective reactions, strain, ease, etc.)

Behavior Segments and Behavior Situations.—What we have attempted to analyze so far are the very simplest types of interactions between organisms and their surrounding objects. In actual life, of course, the response patterns are exceedingly complex.

These complex interactions, however, are merely multiplications and complications of simple behavior segments. We may call them behavior or interactional situations. This means in effect that many stimuli (stimulus functions) and responses (patterns) are operating in any given contact of a psychological organism with the things or persons with which it interacts. Behavior situations are excellently exemplified by circumstances in which the stimuli and responses comprise an indeterminate series. Consider the behavior of a surgeon. Although the original diagnosis determines that certain acts be done with respect to the patient throughout the course of the operation, numerous, unpredictable actions are stimulated by the conditions of the organs involved. Probably every complex adaptation to our surroundings consists of behavior situations rather than of simple behavior segments.

MANY TYPES OF BEHAVIOR SEGMENTS.—Because behavior segments constitute the basic phenomena of psychology one of the primary aims of the psychologist is to investigate and describe the different forms they take while the organism is adjusting himself to the things around him. Now since throughout this book we will have occasion to discuss most of the more prominent types of behavior segments it is unnecessary to enumerate them at present. There are, however, some types that we will not need to treat further in this volume, so we may now consider them as illustrations of what we mean by different, behavior segment types.

Process and Operation Behavior Segments.—When the batter swings at or strikes the ball the response consists of a circumscribed operation with no loose behavior ends. Other types of objects do not stimulate the performance of such definite and determinate responses. Such acts consist more of processes. These are illustrated by the behavior involved in solving mathematical problems or working puzzles. In these cases the persons know definitely what to do, but the carrying out of the adjustment involves numerous indeterminate processes.

Protracted and Momentary Behavior Segments.—Many of our actions are completed in a narrowly circumscribed time limit. I deposit my coin in the slot machine, press down the lever, and the thing is done. The protracted behavior segment involves a

different procedure. It requires a more or less indefinite time for completion. Such an action is well exemplified by the cat which is stimulated by the noise of a mouse to wait at the hole until the latter actually makes its appearance. It is a common occurrence that the protracted behavior segment is at the same time a process behavior segment. The question is merely which phase of the action is stressed.

Witting and Unwitting Behavior Segments.—Finally we may distinguish between types of interactions according to whether the individual definitely does or does not appreciate what he is doing at the time. Examples of the unwitting behavior segment are found in acts performed while one is asleep. When one walks or talks during sleep one is not effectively aware of one's actions and for that reason does not remember having done those things. What is popularly called absent-mindedness consists of similar unwitting behavior. The reader will recognize such interactions as behavior that is popularly termed subconscious and unconscious.

The Stimulus Function

Next we must study how the stimulating object acts upon the psychological organism. This act constitutes the stimulus function.

THE STIMULUS FUNCTION.—When the stimulating object is another person the stimulus function is extremely clear. A's action of throwing something at B visibly provokes a defense reaction on B's part. When A laughs at B, B responds by resenting it; when A flatters B, the latter is pleased and appreciative. Here we can definitely observe the operation of the stimulus function because it inheres in a visible action. The fact that A deliberately intends to make B act, perhaps get a "rise" out of him, adds to the clarity of the situation.

Such deliberation or intention, however, is of no importance from the standpoint of the function of the stimulus. The wind-blown branch dropping from the tree stimulates us to respond equally as much. Furthermore, the stimulus function may not be connected with a visible movement or act at all, but we refer to its action or operation upon us nevertheless. Just the existence of a dead rat in my path evokes a decided nauseous response in me. Merely coming into contact with a rose produces in me a pleasurable

response. We might add, too, that it must be a fresh odorous bloom, since a wilted rose calls out a very different response. The diamond ring in the store window stimulates a desire for it. The D upon the student's examination book arouses in him a depressing response. No doubt the secret of this action on the part of the object lies in the fact that it is reciprocal with an action on the part of the organism.

Objects.—The nature of the stimulus function can probably best be appreciated by a study of its origin. Since any given stimulus function is always tied up with the activities of a particular individual it is easier to observe how some object acquires its stimulus functions by studying a newly born infant. When the child comes into the world there exist all sorts of objects with which he will eventually interact. But up to the time that the child comes into behavior contact with an object, obviously neither the object nor the child do anything with respect to each other. He possesses no reaction systems with respect to the object and the object has no stimulus function for him. In other words, the two things exist entirely outside of any psychological situation or interaction.

Now let us put the child and the object (say a kitten) together. Because the child is an organism that can move and touch things, it strokes the animal and otherwise interacts with it. Now we may expect that upon any later contact with the kitten it will call out stroking reactions on the part of the child. Suppose also that the kitten scratches the child. In this case the kitten also takes on the stimulus function of inhibiting a stroking reaction. At this point the kitten has become a psychological object—namely, it has taken on at least two functions. We may now predict that under suitable conditions the kitten will elicit two kinds of responses from the child. An experimental demonstration of this process of endowing objects with stimulus functions is found in the Pavlov conditioned reflex experiment which is discussed in Chap. 5, pp. 81 ff.

The Stimulus Object.—The stimulus functions of the kitten, however, do not operate unless the child is in contact with it. But since the object has taken on certain functions that operate when the interaction is going on, we may now speak of the kitten as a stimulus object. Obviously, anything can become a stimulus object

if through such interactions as we have been indicating it takes on one or more stimulus functions.

STIMULUS FUNCTIONS DEVELOPED UNDER THREE DIFFERENT CONDITIONS.—We repeat, objects acquire specific stimulus functions through the organism's contacts with them. Not until such contacts occur do objects have any stimulus functions at all for particular individuals. We must now point out that there are different conditions under which stimulus functions originate. These different conditions give rise to what are really three distinct types of functions, which we name as follows:

(1) Universal stimulus functions
(2) Individual stimulus functions
(3) Cultural stimulus functions

Universal Stimulus Functions.—Of all stimulus functions the universal are the simplest. When a hot object stimulates a person immediately to jerk his hand away from it we have a good example of a universal stimulus function. Such stimulus functions are based (a) upon the natural qualities or properties of things, and (b) upon the biological constitution of the reacting organism. Because the organism consists anatomically of a protoplasmic, cellular structure it is sensitive to certain natural properties of things. Universal stimulus functions operate in the interactions of both human and infrahuman animals, hence their name universal. Now what kind of contact between the organism and the object is required for the latter to take on a universal stimulus function? Certainly not a complicated series of interactions. The very first time the two come into contact the psychological relationship is established.

Individual Stimulus Functions.—A and B come into contact with a certain type of stone. The same object stimulates each one to perform a different kind of response. Whereas A is stimulated to pick it up and throw it, B is prompted to preserve it and add it to his collection. In the case of each person the object possesses and performs an individual and private kind of stimulus function. It is clear that here the stimulus function does not depend upon any natural properties of either the object or the persons concerned, for these are the same in both instances. In such a case

it must depend therefore upon the previous private experiences of the individuals with the objects in question. The collector in our illustration has developed a liking for particular stones. For this reason he values them in a way which is not at all true of some other person. It is by this criterion of previous experience with things that we may account for objects possessing stimuli for the liking, disliking, loving, knowing, understanding, and other reactions of particular persons.

Cultural Stimulus Functions.—The fundamental characteristic of cultural stimulus functions is that they elicit identical responses in sets or groups of individuals. The objects in which these stimulus functions inhere therefore elicit shared responses. An excellent example is found in our naming responses to things. All English speaking people call an apple an apple, whereas non-English speaking persons make other types of language response to the same object.

Cultural stimulus functions arise through a process which we shall call institutionalization. That is, groups of persons respond to some object in such a common manner as to make that thing into an institution. This is a process of social development. All the linguistic, religious, political, and custom stimulus functions of objects arise through a very definite type of social or common interaction of persons with things.

CLASSES OF STIMULUS FUNCTIONS.—Stimulus functions are all alike in that they elicit responses. But they may be differentiated on the basis of (a) where they are located, (b) what kind of things possess them, (c) how they get connected with objects, (d) their precise mode of calling out responses, and (e) whether or not they are observable. The following six classes of stimulus functions cover the main types:

(1) Primary and accessory functions
(2) Direct and substitute functions
(3) Endogenous and exogenous functions
(4) Unit and multiple inherence functions
(5) Adjustment and auxiliary functions
(6) Apparent and inapparent functions

Primary and Accessory Functions.—While studying the universal type of stimulus function we observed that the property

of eliciting reactions in organisms is based upon the natural qualities of objects. A stimulus function inhering in an object on this basis we call a *primary function.* This contrasts with the stimulus function inhering through the process of conditioning described on pp. 81 ff. In a conditioned reaction some object can be made to acquire the function which was originally in another object. Thus the stimulus function residing in a piece of meat which calls out a salivary, secretory response can be made to inhere in a bell which is brought into contact with the organism a number of times simultaneously with the meat. A stimulus function of this type we call *accessory.*

Direct and Substitute Stimulus Functions.—In our description of overt behavior we pointed out that the person is always in direct contact with the object to which he adjusts himself. The stimulus function of such an object operates directly upon the organism in the sense that it calls out a response to this thing. In such an object there inheres a *direct* stimulus function.

Consider now the stimulus function of an object which elicits a response not directly to the thing in which it inheres, but to some other object. The marked calendar does not stimulate me to do anything to it. Rather it elicits a response of going some place, or calling someone up on the telephone. Such a stimulus function not inhering in the object to which I actually adjust myself, but in some other, is the typical *substitute* stimulus function.

Endogenous and Exogenous Stimulus Functions.—Endogenous stimulus functions reside in the psychological and biological actions and conditions of the individual. The stimulus to get oneself some food may be located in the biological hunger contractions of one's stomach. Similarly, the response of going to the dentist is elicited by a stimulus function residing in the aching tooth.

By contrast, *exogenous* functions inhere in all kinds of objects which are obviously different from the individual himself and his actions. For example, I may not even "think" of food until I hear the sound of the dinner bell.

Unit and Multiple Inherence Functions.—All the stimuli which we have been describing so far inhere exclusively in a single object, quality, or condition. All such functions we may call *unit*

inherence functions. But there are other forms. I do not decide that to run is the better part of valor unless I am about to be attacked by several individuals. The stimulus here is located in a plurality of objects. This is the *multiple inherence* type of function.

Adjustment and Auxiliary Stimulus Functions.—What *adjustment* stimulus functions are, is suggested by the adjustive nature of psychological interactions. They bring about an adjustment to an object. On the other hand, the principle of the *auxiliary* functions is that they accompany an adjustment stimulus. Both the adjustment and auxiliary stimulus functions are excellently exemplified in the case of language reactions. When I say "look at that building," your response is simultaneously aroused by the building in question (adjustment stimulus) and by what I say (auxiliary stimulus). By calling the building stimulus the adjustment function we indicate that the interaction is primarily concerned with that rather than with me.

Apparent and Inapparent Stimulus Functions.—We conclude our classification of stimulus functions with a pair of rather obviously contrasting types. When I am stimulated to say no to your request I can definitely point to you as the locus of the stimulus function that elicited my response. In other words, the stimulus function is quite *apparent* and definite. On the other hand, when I suddenly begin to hum a tune, I may not be able to say what has stimulated me to perform this action. The operation upon me of *inapparent* stimulus functions may entirely escape me.

Media of Contact

Natural events take place only under particular definite conditions. In order that any psychological interaction should occur it is essential that the organism be able to come into contact with the stimulus object. In the absence of light we are precluded from performing any kind of visual reaction to things. Without the light medium we cannot discriminate, choose, like, or in any other manner react to the colors, sheen, visual shape, or other optic qualities of objects. Similarly, to be able to react to sounds a medium of waves must be present. Because these air waves and light rays are the means of being stimulated and being able to perform responses we refer to them as *contact media.*

There are, of course, many kinds of contact media. Light and air waves mediate contacts of interactions performed when the organism and objects are located at a distance from each other. Another form of distance medium consists of the gaseous particles which must pass from the olfactory object to the organism when it performs smelling behavior.

In addition to the distance media there is a large series of proximate media operating when the organism and its stimulus objects are not separated in space. To interact with the taste qualities of things we must have immediate chemical contact with them. Taste reactions are thus mediated by liquid solutions of various types. To perform touch reactions the organism must, of course, be in immediate contact with stimulus objects. The medium for pain is even a more intimate one. There must be some definite change in the tissues concerned.

Psychologists working in cooperation with physicists and physiologists have been able to work out some specialized facts concerning the media for visual and auditory reactions. For example, it has been fairly well established that the length of the light rays mediating visual reactions to the visible part of the spectrum range from 390 millionths of a millimeter (symbolized 390 $\mu\mu$) at the violet end to 760 or 780 $\mu\mu$ at the red end. Similarly, the media for auditory stimulation are conceded to range from 16 vibrations per second to 25 or 30 thousand. In the reading lists at the end of the book is indicated relevant literature on the subject of stimulational media.

Some Misconceptions Concerning Stimulational Media.—A number of unfortunate misconceptions exist in psychology with respect to contact media. For example, these contact media are regarded as the stimuli. Furthermore, it is believed that it is the function of these stimuli to bring into existence the qualities of things. For example, in the case of seeing a color the colorless light rays must first operate upon the eye with an after-effect in the nervous system of the organism, before color qualities exist. The color qualities, it is said, "appear in consciousness." This is tantamount to a belief in the creation by the nervous system (or the mind with which it is supposed to be connected) of the color qualities of things. According to this type of thinking the world of

the organism consists really of physical radiation of the ether wave or air wave types. All the color, sound, smell, and taste qualities are only psychic parallels of bodily actions. It is in order to guard against such intellectual confusion that we must study and understand the role of media in psychological events.

Why is it that psychologists can so misconceive the nature of stimulational media? The situation appears to the writer as follows: The stimulus is looked at biologically, that is, it is presumed to be a condition which arouses a biological organism to action. The misconception seems to be due therefore to a confusion of the psychological response of distinguishing a quality of a thing, and the biological description of how the eye works.

The Interactional Setting

"What a well-behaved little man," is the judgment passed by the elderly lady upon the boy whom she observes so carefully helping his little brother keep up with the rest of the gang in their march toward the swimming hole. But could she only see him without herself being seen! What a different set of reactions the little brother elicits when outside the range of the critical eye! Such irritable scolding of the younger chap, such resentment at the interference with one's freedom of action! Great therefore is the difference that the surroundings or interactional settings make in one's psychological conduct.

This illustration then may be used to indicate that the stimulus function, the response of the person, and the medium of contact still do not tell the whole story of a psychological event. The setting or background of the interaction must be added as one more factor. This latter feature constitutes one of the essential conditions under which the psychological event occurs. We know that the organism is capable of performing a large variety of responses to things. Also objects are endowed with numerous types of stimulus functions. Which of these correlated stimulus functions and responses shall operate at any given time depends upon the interactional background.

The setting of a psychological event may produce its primary effect upon one or more of the three features of a psychological event. It may condition primarily (1) the stimulus object, (2) the reacting individual, or (3) the total interaction.

(1) First, let us consider the setting which pertains more particularly to the stimulus object. Put two equal squares of red paper on a black and white background respectively. You cannot miss the different effects upon you of the different settings of the same colored object.

(2) Among the best examples of the operation of interactional settings upon the individual are those taken from the realm of personal hygiene. What an enormous difference fatigue, sleepiness, or ill health make in the way things appeal to us, or in the readiness with which we react to them. That life wears a pessimistic aspect for the dyspeptic is a proverbial truth. Moreover, no one can fail to observe how the stirrings of well-being tint all the world with a rosy hue.

(3) Examples of the environmental effect upon total psychological interactions are supplied us in great number by such illustrations as head this section. The presence or absence of certain persons makes vast differences in psychological events. Similarly, our interactions with the same objects vary according to whether we are in church, woods, or urban environment. James writes, "My young children are afraid of their own pug-dog, if he enters their room after they are in bed and the lights are out."

The Reaction System

Two Kinds of Factors in a Reaction System.—It is now time to analyze the action units proper. But before we do so we must reiterate once more that whenever the organism performs any kind of action, no matter what, that action constitutes the operation of the entire organism. Any specific act, however, can be analyzed into a series of component happenings. There are two guides to this analysis. In the first place, we distinguish a series of factors in the total act on the basis of the organism's structural organization. That is, we can point out the contribution of, or the part played by, the organism's biological characteristics in the total action unit.

In the second place, we isolate a series of factors which represent the historical interconnection between the complete organism and the objects of the interaction. By contrast with the first set of action elements the present set is, from the biological standpoint, more ecological than structural, and in addition represents more

distinctly human and cultural components. Let us consider these two series of factors in order.

Factors Isolated on the Basis of Biological Structure[3]

1. Muscular action	2. Neural action
3. Glandular action	4. Skeletal action
5. Receptor action	6. Effector action
7. Tendon action	8. Skin action

Muscular Action.—There are two kinds of muscular components in reaction systems. First, there are the specific flexions and extensions, contractions and relaxations of striped muscle tissue which can be regarded as the basis of what are ordinarily called movements, namely, changes of relationship between the organism and the objects around it. Muscle action is likewise readily identifiable in the configurative activities, those different ways in which the organism distributes itself in space, as when the individual goes through the different evolutions of a calisthenic exercise. Postural activities as when standing, stretching, lying down, and kneeling also illustrate muscle action components. And finally we must cite such manipulative responses as grasping, reaching, tearing, and constructing as examples of complicated muscle behavior.

A quite different sort of muscular action consists of the contractions of the smooth muscles. The operation of these tissues forms the basis of the actions of such visceral and intraorganic organs as the alimentary tract, heart, lungs, blood-vessels, etc. We find these reaction-system components operating prominently in feeling responses.

Neural Action.—Every complex organism may be looked upon as an intricately organized series of segments and appendages. To enable its responses to be definitely directed toward stimulus objects the total individual must operate as a unit. It is the neural activity which primarily contributes to the gross integration and coordination of the total reaction. This neural action consists of the passage of impulses over the various neural tissues of the organism.

Since the organism always operates as a complete whole it inevitably follows that the neural apparatus always operates as a totality. For analytic purposes, however, we can logically isolate

[3] Descriptions of these structures are presented in Chaps. 22-24.

three phases of neural conduction on the basis of the individual's biological organization.

In the first place, we may separate out the impulses travelling from the periphery of the organism or from the different end organs to the central parts—namely, the brain and spinal cord. These are the *afferent* neural impulses. Next, we may separate out impulses travelling between different anatomical points throughout the *central* portions of the whole nervous system, the central neural actions. And finally, neural action includes impulses travelling from centers throughout the total neural mechanism to the periphery of the organism and to the various visceral organs located within the body wall. These are called the *efferent* functions.

Glandular Action.—Glandular activities consist of a large number of secretory processes which are continually operating and whose products are distributed throughout the total organism. For the most part these activities provide the energy factors which are necessary in order that the organism can survive and adapt itself to the various conditions and changes in its surroundings.

We may discriminate between the different functions of glands on the basis of the directness of their contribution to the psychological response. Generally speaking, glands can be divided into two types. First, the maintenance glands, whose secretions have to do definitely with the building up of tissues and the elimination of waste products. Among these are (1) the alimentary glands—namely, the salivary, stomach, pancreas, liver, and kidney organs, and (2) the glands of the skin. The functions of these play their part in psychological responses by keeping the organism alive and in good health.

A closer connection between glandular action and psychological behavior is supplied by the regulating glands. Among these are numbered the secretion of the endocrine or ductless glands, such as the thyroid, the parathyroid, the suprarenal, the pituitary, as well as the sex glands, the pancreas, and the liver. These activities may be regarded as definite phases of the various reaction systems and are especially noticeable in feeling and emotional reactions. The same thing may be said about the activities of the lachrymal glands which are not readily classified as either maintaining or regulating functions.

Skeletal Action.—It is the contribution of the skeletal system to provide the rigidity necessary for complex action. Again, reaction systems involve all sorts of behavior changes when the individual is in contact with his stimuli. Since the skeletal activities consist of a large number of varying lever actions, as in joint articulations, we can readily understand the particular place of the skeletal components in the total action system.

Tendon and Ligament Actions.—In responding to stimuli the organism must bend, twist, and strain in numerous ways. Here is indicated the part played by the operation of tendons and ligaments in the various reaction systems. Briefly, we may regard these activities as furnishing the various stresses, strains, and pulls which enable the individual to adapt himself to the objects with which he interacts.

Receptor Action.—During the evolution of organisms they have developed specialized sensitivities to their environing conditions. It is the receptor mechanisms which make possible the localizing of contacts between the organism and the surrounding things and conditions. Thus the retinae of the eyes may be regarded as the special points of contact with visual objects. The cochlea of the ear contributes special sensitivity to sound qualities. Similarly, the taste buds and the mucous membrane of the nose serve the same functions for taste and smell qualities. A large number of such endorgan-actions distributed throughout the skin in the same manner contribute to the total interaction of the organism with its environment. The localizing functions of these receptor actions make for the unified and effective contacts of organisms with their stimulus objects during the course of psychological interaction.

Skin Action.—Many and varied are the contributions of the skin action to the total reaction system. In the first place, skin action is preservative. It keeps the organism from absorbing fluids from its surroundings and at the same time serves to excrete waste products. Also the skin operates to equalize the temperature of the organism as a whole.

Skin action contributes more definitely to psychological responses through the end-organs which are localized in the skin, and especially those prominent in pain, temperature, and pressure responses. Again, through its connection with sweat glands and

hair structure, the skin plays a large part in the violent emotional activities.

Factors Isolated on the Basis of the Organism's Relation to Objects.—

1. Discriminative Action
2. Attending Action
3. Feeling Action

DISCRIMINATIVE ACTION.—From our study of the general nature of psychological interactions we have learned that each reaction system is differential. Each unit of response is decidedly correlated with a specific function of an object. Whatever the stimulus function is based upon, whether upon the object's natural properties or entirely upon the previous behavior connection of the organism with it, the individual's action is discriminate.

ATTENTION ACTION.—Whenever an interaction takes place between an organism and a stimulus object we have a new and unique event. This signifies absolutely that the organism has changed its action from one stimulus object to another. This change of response we call the attentional factor. We may be sure that the attentional factor is apparent even if the organism is stimulated by some different stimulus function of the same object. Indeed, restimulation by the same object in no wise can occur without this change of behavior direction.

FEELING ACTION.—The third behavior factor consists primarily of some kind of effect upon the organism. This may be a tension or excitedness of the individual when he takes part in an interaction with a surprising or unexpected thing, or some diffuse pleasant or unpleasant glow when the object is interesting or pleasant, or possesses opposite properties.

ACTION FACTORS ARE ALL ABSTRACTIONS.—All of these factors it is clear are abstractions. The activity of the organism is a single unitary act. These factors constitute then only descriptive components of action. No psychological action can be reduced either to sheer muscular activity or pure neural processes or any combination of these. Perhaps the absolute integrity of the reaction system can be sufficiently emphasized by the consideration that no single

factor is of greater importance in the total action than any other. The muscular, glandular, or neural factors, for example, are no more important than the skeletal, skin, or any other component. How then do we arrive at these components? In this way.

It so happens that in some behavior segments certain components are more prominent than others. For example, when the individual

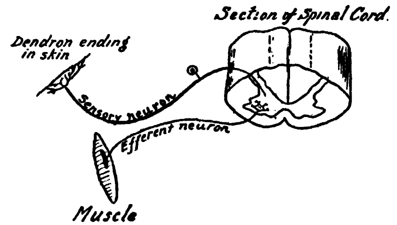


Fig. 5—The conventional pedagogical description of a reflex action. An example of an oversimplification of a complex interaction.

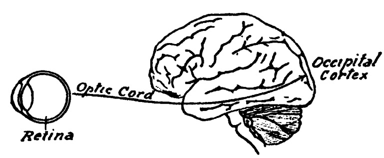


Fig. 6—Exemplifying an oversimplified description of the act of seeing.

is anticipating the pleasure of consuming a juicy beef-steak we may isolate the primarily secretory actions. This means to say that we neglect all that happens except the salivary gland secretions. Again when a person's action consists of lifting a heavy object we tend to overemphasize the place of muscular action in the total response.

Although it is necessary when describing complex phenomena to make abstractions of all sorts we must be very careful not to be misled by them. To illustrate, when we attempt to describe the neural factors in a reflex action we present a figure (Fig. 5) showing two or three neurons connected at a certain level of the spinal cord. The reflex action appears then to be described as a sharply localized phenomenon. We abstract the simplified mechanism not only from all the other parts of the nervous system but also from the other components of a reaction system and from the organism as a whole.

Another instance of this abstraction process is illustrated by the drawing (Fig. 6) which is presumably meant to show that seeing consists of the operation of the retina, optic nerve, and the cortex. As though seeing were exclusively and purely a physiological action.

WHAT A REACTION SYSTEM REALLY MEANS.—Although no act can be actually dissected into portions or parts we may be absolutely certain that it involves or incorporates all of the different

features we have suggested. How then shall we envisage the reaction system, compelled as we are to do justice both to its unitary and indivisible character on the one hand, and to the existence and operation of all its factors on the other?

The answer is that we must regard a reaction system as merely a behavior configuration, a way in which the organism distributes

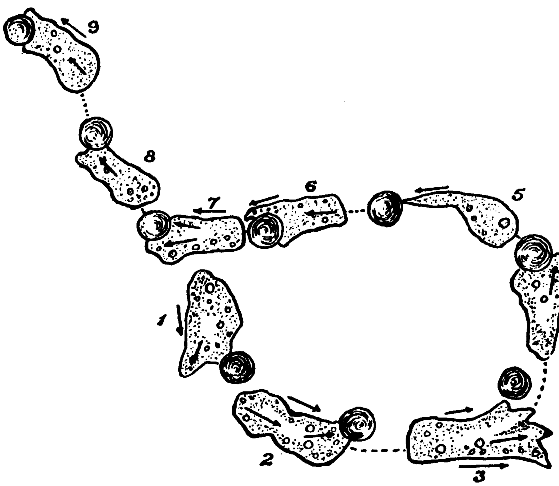


Fig. 7—Different behavior configurations of an ameba involved in the pursuit of a food object. From Jennings, *The Behavior of the Lower Organisms,* by permission of The Macmillan Co., publishers.

itself in relation to the space in which both it and its interacting objects are located. Such behavior configurations are beautifully illustrated in the well-known observation of how the ameba interacts with its food particles (Fig. 7). We may also acquire a definite conception of a reaction system by considering the unit action or configuration of a person when he is walking, jumping, or boxing. Figs. 8, 9, 10, afford excellent graphic suggestions concerning the behavior configurations of reaction systems.

Classes of Reaction Systems.—Any significant classification of reaction systems must be made, of course, in terms of the total behavior segment. This type of classification we have already attempted. There remain, however, certain characteristics of reaction systems which may be pointed out here.

Reaction systems may be *crude* or *subtle.* Many of our responses involve reaction systems which are describable as gross movements or crude actions. Especially is this the case with the

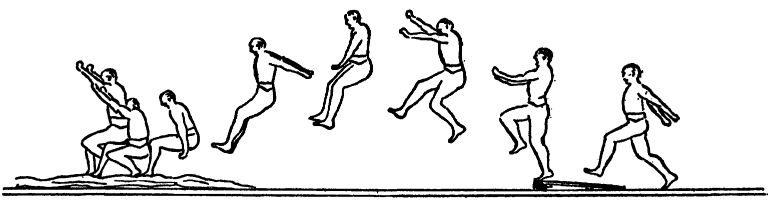


Fig. 8—Behavior configurations of a man performing a long jump. Drawn from a chronophotograph in Marey, *Movement,* Appleton, publishers.

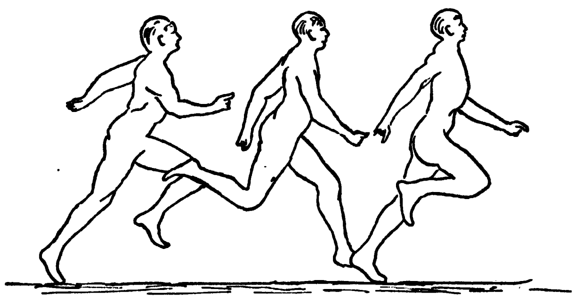


Fig. 9—Behavior configurations of a runner. Drawn from a chronophotograph in Marey, *Movement,* Appleton, publishers.

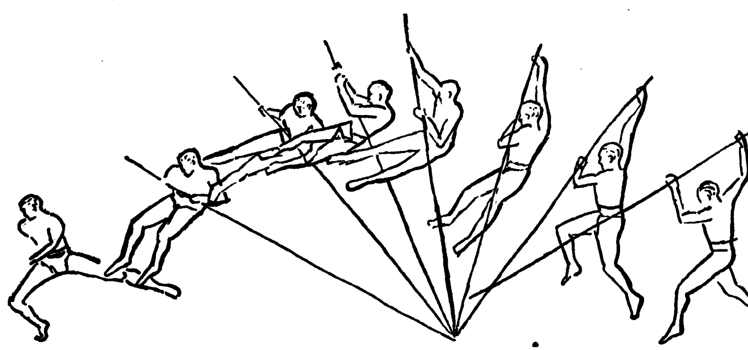


Fig. 10—Behavior configurations of a pole vaulter. Drawn from a chronophotograph in Marey, *Movement,* Appleton, publishers.

reaction systems of the overt effective type. It is from such actions, for example, breaking something, running, or manipulating objects, that we usually abstract the skeletal muscle action as the most prom-

inent components. On the other hand, many affective responses, acts like dreaming, planning, and remembering, involve reaction systems that are subtle in their operation.

Reaction systems may be *apparent* or *inapparent*. From the standpoint of an observer crude reaction systems are generally speaking entirely open to inspection. Not so in the case of subtle reaction systems. In many instances no one but the person performing such actions is aware of them and certainly only the person himself knows the details of the subtle behavior that is going on. How fortunate it is that the fisherman, who is telling someone of the large trout that got away, is not able to discern the doubting and sometimes positively disbelieving reaction which is stimulated by his story.

CHAPTER III

THE REACTIONAL BIOGRAPHY

The Nature of Reactional Biography

We have already learned in Chapter 1 that all psychological interactions are historical; that is, they originate in the individual's contacts with things. It is this historical interconnection with objects which distinguishes psychological from biological and physical phenomena. Again, while studying the stimulus function (Chap. 2) we learned that the specific character of a psychological interaction is determined by the individual's prior reactional experience. The complete behavior experience of an individual is called his *reactional biography*. It is through the behavior details of this reactional biography that the individual develops all of the responses that he ever performs. Whatever he can do, his capacities, knowledge, skills, and behavior powers, are engendered in his reactional biography.

Consider your behavior with respect to the book you are now reading. The complex acts of reading and understanding have become what they are through a long series of contacts with letters, simple words and phrases, complex words and phrases, and the innumerable objects with which they are connected. We can go back into each person's history and locate the point at which he could not distinguish one word from another or even one letter from another. So it is with every other action that he performs. In other words, psychological interactions as specific events can be traced back to their actual beginnings. If this is true, surely it is not too much to say that the facts of reactional biography are among the most important in the entire realm of psychology.

Two Types of Behavior Origins.—The behavior details of reactional biography show us that our responses have two distinct kinds of behavior origin: (1) the immediate and (2) the progressive. The latter type we have just indicated with our reading illustration. To be able to read we must first go through a long

series of progressive contacts with reading materials and what they represent.

This is not true, however, in the case of the immediate origin of behavior. In this instance a number of contacts with objects is not required. Instead, the organism and object begin to interact adequately upon their first contact. The infant immediately withdraws his finger from the candle flame. Why this happens is obvious. Such actions are built up directly upon a basis of prior, biological interactions, which result in the evolution of an organism's sensitivity to such stimuli. Needless to say, such interactions constitute the simplest possible psychological behavior. For the most part such activities are stages in the evolution of more complex psychological interactions.

When Does the Reactional Biography Begin?

Since psychological organisms are animals, the ability of the organism to enter into certain kinds of interaction with things depends upon its biological maturity. For instance, not until the infant attains the biological stage of development necessary for the coordination of its anatomical organs can it interact with things which require creeping or walking toward those objects. In order to interact verbally with persons, the organism must attain a still higher stage of biological development. Consequently in searching for the beginning of reactional biography we must look to the organism's biological growth.

Let us briefly recall some stages of this development. The biological individual is engendered by the union of a male (spermatozoon) and a female (ovum) reproductive cell. Through the favorable interaction of the embryonic organism with its environment it passes through a series of progressive changes until it becomes in its structures and functions like the older members of its species. In the human organism these developments are far from complete when the individual is born. A great amount of development occurs as soon as the environment changes from the sheltered confines of the uterus, to the numerous objects and persons with which the organism interacts after birth. Both these types of development taken together constitute a large part (roughly the first twenty-five years) of the organism's life history. The rest consists of a gradual deterioration and disorganization beginning at about thirty years of age and culminating in the death of the indi-

vidual.[1] The embryological development of the organism consists mainly of the organization and perfection of organic structures and the development of their functions. In a smaller degree, of course, the biological growth of the individual marks the beginning also of its reactional biography or psychological history.

Accordingly, we date the beginnings of an organism's reactional biography at some point during its later intrauterine development. Naturally enough the early interactions with things extraneous to the organism are extremely limited, for it is in contact with few such objects until after it is born. However, we know the organism can respond to functions and conditions going on within its own self. Every organism reacts to its own digestive processes, especially when they are somewhat deranged. Since we may well assume that such reactions take place before birth, we may conclude that the psychological life of the organism begins at that time.

Reactional Biography Parallels Biological Maturation

Psychological behavior does not occur then until the organism reaches a certain stage of biological maturity. This means in effect that the organism exists as a biological individual before there is any kind of psychological interaction. This minimum biological development enables the organism to enjoy only very elementary contacts with things. In order to interact on a larger scale with surrounding objects or to perform more complex reactions a still greater biological maturity must be achieved. A child cannot speak until after it is vocally well coordinated. In general the development of complex types of psychological interactions must wait upon the increasing maturity of the individual. In consequence, we find, especially in the early years of the organism's reactional biography, that its psychological development parallels its biological development. Thus standing, walking, running, and jumping parallel a series of stages of increasing biological maturation.[2]

Divergence of Reactional Biography and Biological Life History

As we have already intimated we may at some point in the life history of the organism determine a period of practically complete

[1] For an excellent discussion of biological development see Robbins, W. W., et al., Growth, Yale U. Press, 1918.

[2] Naturally the developmental periods are not absolute and distinct but rather overlap and merge at various points.

biological maturity. All the structures and functions are as fully developed as they ever will be. In fact, the next step in the course of life history is a deterioration ending in death. But though the individual as a biological organism is at his peak or even going down hill, he may be constantly progressing upwards as a psychological being. Long after the individual has reached his full biological development his psychological behavior and development continues to expand and evolve. In other words, there is no point at which the psychological growth of the organism necessarily ceases. Even during the deterioration period of old age he can enter into new types of interaction with objects and continue to develop psychologically even to the very moment of death.

This lack of complete parallelism between the psychological and biological developments we may refer to as a divergence in the individual's total life history. How the biological and psychological developments can diverge is excellently illustrated in the observation that two persons may be of the same chronological or biological age while one is several years psychologically advanced beyond the other.[3] The accompanying schema (Fig. 11) gives us a visual representation of the beginnings, parallelism, and divergence of the reactional biography and biological life history. The approximate biological periods are indicated below.

Approximate Periods of Life History

		Conception
0–2	weeks	Germinal period
2–8	"	Embryonic period
8–40	"	Foetal period
40–42	"	Neonate period
42–56	"	Early infancy
56–104	"	Later infancy
2–6	years	Early childhood
6–10	"	Later childhood
10–12	"	Pre-adolescence
12–20	"	Adolescence
20–25	"	Youth
25–30	"	Adulthood
30–50	"	Middle age
50–		Old age

[3] We are also familiar with the phenomenon of psychological deterioration while the biological organism is normal and complete.

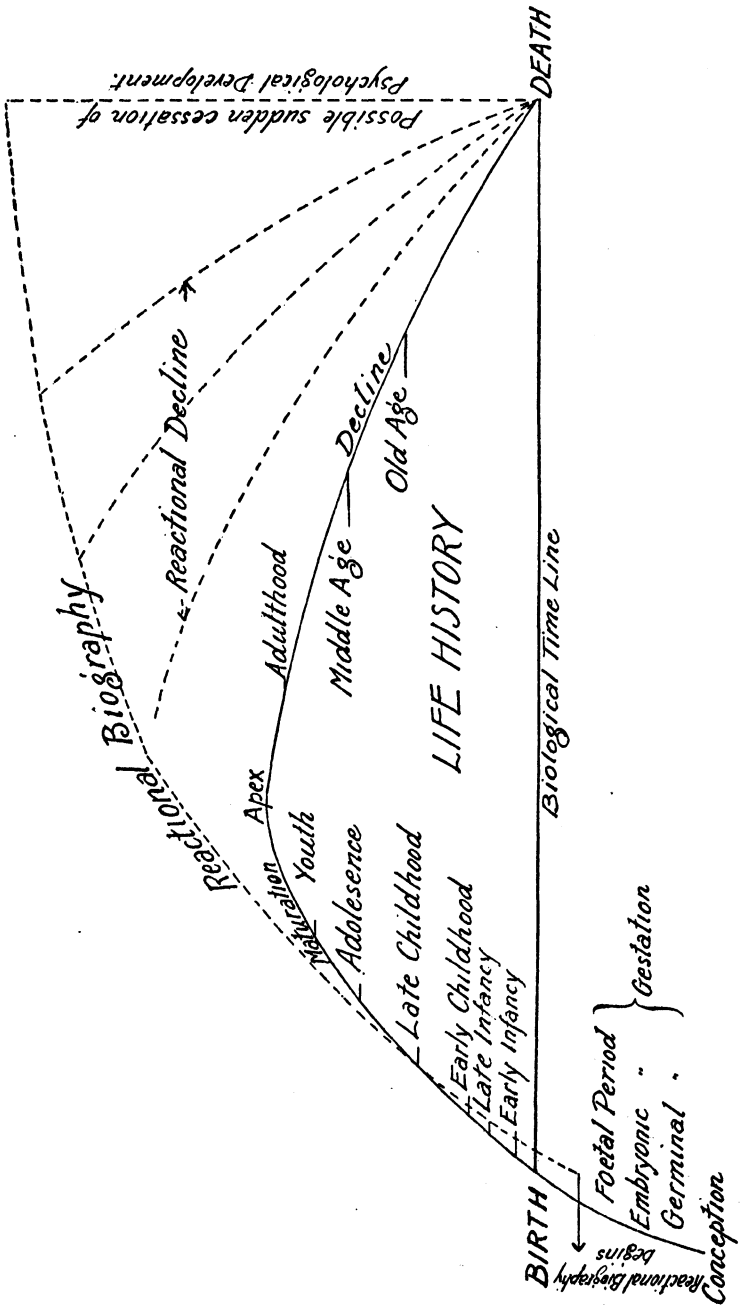


Fig. 11—Diagram suggesting development of reactional biography in relation to biological life history.

Two Principles Implied in the Divergence of Psychological and Biological Development

The great divergence of development between the biological life history and the reactional biography of the organism points to two distinct principles important in the study of psychology.

Psychological Reactions are Not the Mere Functions of Biological Structures.—Every psychological response is the activity of a biological organism. Also we have seen that the organism cannot have contacts with things until it has reached a certain stage of development. Until the various organs of the individual are developed and coordinated, the organism cannot perform reaching or walking or any other kind of psychological response. The point to be emphasized here is that in spite of the exceedingly intimate relationship between the biological and psychological developments, psychological reactions are not merely the operation of biological mechanisms. We can no more identify psychological responses with biological (physiological) functions than we can identify them with the operation of chemical and physical factors that are also phases of every psychological interaction.

Take the case of drawing. Do we know the facts about making a picture if we regard it merely as the biological operation of the hand, that is, the making of movements on paper? No, we must go further. The intrinsic psychological character of drawing is a fact of the specific intimate contact of the person with the things around him. We must take account of the different human circumstances that have their influences upon the individual. First, he must live in a society where drawing is practiced. The making of graven images is taboo in certain societies. Secondly, he must have been in contact with those who could teach him the technique of drawing. Thirdly, he must have had some interest in the drawing process or at least have been willing to acquire the ability. Finally, there must be circumstances which condition the individual's present performance of the drawing activity. A psychological fact, then, may be regarded quite as much an anthropological as a biological affair. This is an obvious truth in the case of all complex psychological behavior.

Biological Factors Participate in Psychological Behavior.—Not only must we not regard psychological conduct as sheer biological activity, but also we cannot look upon the biological

concomitants of psychological responses as the causes of the latter. How then shall we understand the relationship? Probably the most effective way is to consider the biological factors as participants in the psychological response—namely, the operations of the biological mechanisms are factors in a psychological event. While studying the reaction system we observed that every psychological response consists of one or more configurative changes in the postures or movements of the individual. Although speaking is not merely the operation of the lips, tongue, and larynx, those structures and functions inevitably participate in the articulate form of speech.

The participation of biological factors in psychological phenomena is exactly like the participation of physical factors in psychological action. We all know that unless an individual has a certain mass he cannot lift things that others can, since the individual while performing psychological actions must conform to the laws of physics. In many reactions what we ordinarily call the biological factors are really physical factors. For example, in lifting a weight the arm operates as a lever according to the mechanical laws of levers. In the same performance we can analyze a large series of mechanical operations involving many other parts of the organism. As a record of fact in almost every psychological situation we can quite definitely analyze not only the biological but also the physical and the chemical participants.

Biological and Anthropological Influences upon Reactional Biography

Since psychological interactions involve both biological and anthropological factors we shall now consider in more detail how such elements influence an individual's reactional biography.

Biological Influences.—When an infant is born it is obviously a reproduction of parents who have attained a particular place on the evolutionary scale. Accordingly, the human infant possesses in its biological make-up the possibility for developing certain types of conduct. When it is born we may predict that it will be human in its behavior. It will have possibilities of development which are not found in the infrahuman animals. Whatever advantages or disadvantages are found in the human type of organism will be applicable in the case of this particular infant.

Such possibilities accrue to the individual's species through evolutionary processes which are summated throughout aeons of time. This infant will then be an upright walking animal, bilaterally symmetrical, and include in its organization particular kinds of organs, such as a special kind of nervous system, muscles, skin, receptors, and so on.

Let us be warned, however, that the biological equipment with which the individual comes into the world in no sense counts as more than a possibility for its psychological behavior. Despite the fact that the organism belongs to a speaking species, that is to say, organisms which have evolved language, it will not speak unless it passes through a reactional or psychological history. In other words, it must acquire speaking reactions; it must learn to speak. The same principle applies to the whole series of psychological phenomena.

Being born a human animal, therefore, merely means that the individual is capable of developing a reactional history. It does not mean that he inevitably will do so. This behavior possibility really means very little in terms of specific performances, since in order to be able to perform complex psychological actions the organism must pass through a complicated interactional experience. This is the only legitimate sense in which we may speak of a biological basis for psychological phenomena.

Biological Limitations.—The reactional biography of an individual not only depends upon the biological nature of the human species but also upon various happenings to the organism during its biological development. Thus if some accident should happen to the individual during the period of gestation, while he is being born, or at any later period of development, the possibilities for his psychological developments are to this extent decreased. Should the organism be born with its biological parts injured or destroyed it cannot develop certain psychological activities. The blind or deaf organism cannot develop visual or auditory responses. Worse still, should the organism be injured so that it does not develop normally, as happens in the case of idiots, naturally there will be no normal psychological development.

Some years ago the writer had in one of his classes a medical student who from infancy suffered from Jacksonian epilepsy. The pressure of some abnormal skull-bone formation upon his brain produced frequent convulsions and interfered with his general psy-

chological development. After years of backwardness a successful operation made it possible for the young man to go to school. When he came under my observation he was well on his way toward catching up with his fellow students.

Similarly, diseases of various sorts, while not destroying or injuring the structures of the organism, may operate as deterrent factors preventing the organism from coming into contact with various stimulus objects. Thus its psychological development is limited. In this case hygienic conditions rather than biological destruction prevent the organism from developing.

Anthropological or Civilizational Influences Upon Reactional Biography.—The student of psychology will realize at once that there is no such thing as mere behavior. Every psychological fact must be described in its exact details as a particular kind of interaction with things. No one ever just talks. Speaking is always a very particular form of response to a specific stimulus. To speak means to speak French or English. Moreover, a very specific thing is said. Not only does the speaker talk of certain things but he also speaks of those things in a certain way. Conversation with a child is different from conversation with an adult. With a friend one speaks otherwise than with a stranger. What is true of speech is just as true of thinking, believing, constructing, remembering, playing an instrument, singing, etc. When we take account of the details of psychological interactions we have no trouble at all in seeing the important place that anthropological conditions take in behavior development.

Anthropoligical conditions not only play a great part in the development of actions, but they also influence their later performance. In other words, to understand why individuals believe, speak, create, and destroy things one must know the kinds of anthropological or civilizational conditions under which they perform their behavior. These conditions constitute the inevitable auspices of all human conduct.

Anthropological Possibilities and Limitations.—Stefansson, the Arctic explorer, writes[4] concerning Eskimo women as follows: "The women as seamstresses are priceless . . . . Seamstresses such as these we need so badly that we are willing to engage along with them comparatively useless husbands and families of

[4] The Friendly Arctic, Macmillan, 1921.

several children. . . . . The preparation of the skins is tedious to anyone but Eskimo women brought up to the idea that it is their proper work, while such skill as theirs with the needle is acquired only by years and generations of practice. All their needlework is excellent and the waterproof seams are probably the only really waterproof sewing in the world. Our bootmakers do not conceive that a seam may be in itself waterproof, and attain their ends by rubbing or working some sort of grease into the needleholes. Among the Eskimos no seam is considered passable unless it is waterproof without greasing. If a good seamstress sees you rubbing oil on boots she has made she is likely to become angry, considering it an insult to be suspected of a seam that needs grease to cover up deficiencies of workmanship."

Similarly, we all know that men reared in a machine culture can invent and use machinery not possible for people of nonmachine groups. Again we may look to the civilizational features of one group for great artistry, as the Italians in the Renaissance period, and to another for superior capacities in legal and political administrations as the Romans of the Empire. So fundamental are these cultural influences that they have led to the erroneous notion that men are qualitatively different in animal nature.

But cultural possibilities and limitations are not confined to skills and capacities. Wherever certain ideas and beliefs prevail we may expect them so to affect the reactional biographies of persons that they acquire and perform such behavior. Thus members of Christian communities think and believe differently than do those of Mohammedan or Hindu cultures. This means in detail that anthropological conditions determine what specific stimulational functions objects will be endowed with under different human auspices. It is hardly necessary to multiply instances. Suffice it to mention the different virtues, manners, philosophic attitudes, superstitions, and mysticisms of men of different cultures.

The psychological possibilities contributed by anthropological conditions are supplied mainly by the opportunities for contacts with stimuli. Anthropological conditions provide the objects, techniques, thoughts, myths, beliefs, language, and other accoutrements of civilization with which persons interact and through contact with which they build up all sorts of behavior equipment.

Conversely, the absence of cultural elements in a given society means that a distinct anthropological limitation is placed upon an

individual's development. Every society or community may be regarded as either having certain civilizational factors or lacking them when compared with some other set of persons. A simple society has no need for writing or reading; therefore the persons living in such a community never see written material and as a result do not build up reading or writing behavior. Let us point out similar limitations found in the lack of mathematical techniques, stone building, particular kinds of agriculture, religions, social organization, etc. Without the presence of such anthropological things the person's reactional biography cannot be influenced by them to the end that he will acquire certain responses to them.

An apt illustration showing how cultural conditions affect the fundamental processes of comprehension is supplied by a story which Stefansson tells about Eskimo children.[5] A New England school teacher had a group of boys and girls concerning whom he and the explorer both agreed had as much native intelligence as children of similar ages and grades in New England. After lecturing to them about the causes of the Revolution in which, of course, the "Boston Tea Party" played a prominent part, he gave them an examination in which appeared the question, "Why did the American colonists go to war with England?" One of the brightest boys wrote the following answer: "It was no wonder that the Americans got angry at the English, for the English were so mean they put tacks in the tea they sold the Americans." Writes Stefansson, "The point is obvious. Had the lectures and reading been on the Pure Food and Drugs Act, every pupil in the Barrow school would have understood, because the adulteration of food by traders is to them a familiar thing; but taxation, with or without representation, was a foreign idea and essentially incomprehensible." The story is told by the explorer in order to illustrate the great gulf that must exist between what the Eskimo understands by Christianity and what the missionaries attempt to teach them on the subject.

Some Important Studies of Reactional Biography

Psychologists generally are beginning to appreciate with increasing clarity that the understanding of psychological phenomena is greatly enhanced by the investigation of the origin and development

[5] My Life with the Eskimo, Macmillan, 1913.

of specific activities of the organism. It seems plain that such behavior origins can be studied best in the newborn infant. Such studies, of which there is a constantly increasing number, effectively add to our knowledge of reactional biography.

At the Yale Psycho-Clinic Gesell has been devising methods of observing the development of the earliest behavior patterns, and of formulating scales for measuring the development of individuals. In Fig. 12 is shown a photograph of the observation dome which he

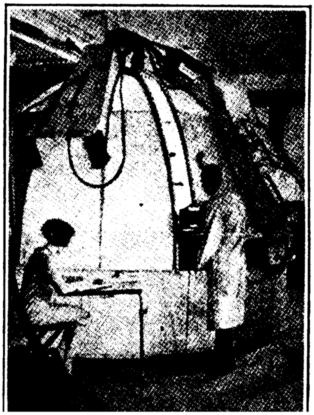


Fig. 12—Photographic observation dome used by Gesell in his studies on Infant Behavior. From *The Foundations of Experimental Psychology,* Clark Univ. Press.

has designed for the study of infant behavior. The accompanying photographs of infants (Figs. 13, 14) illustrate some of the typical responses in the early months of psychological life.

For a number of years Weiss and his students at Ohio State University carried on very carefully controlled studies on the earliest behavior development of infants. Much valuable information is obtained from such work concerning the beginnings of the psychological existence of individuals.

A considerable amount of data concerning reactional biography has been accumulating at the various child institutes which have been recently established. Prominent among these are The Institute of Child Welfare at the University of Minnesota, the Child Welfare Research Station at the University of Iowa, and the Institut Jean Jacques Rousseau at Geneva. While the various studies made at these institutions do not always stress the genetic and develop-

mental aspects, the work has revealed the processes of the early acquisition of coordinative, manipulative, linguistic, and general social behavior.

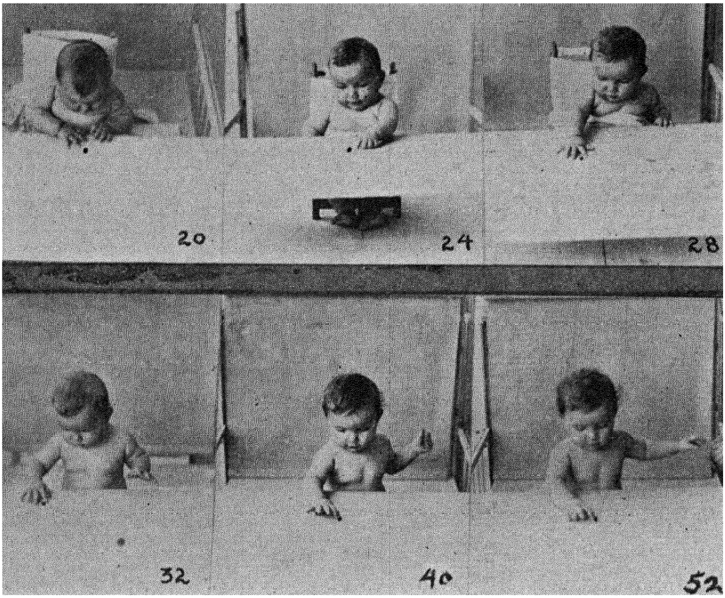


Fig. 13—Gesell's development series showing the growth of pellet prehension patterns: "20 weeks—immediate, definite regard of pellet, sometimes with increased hand-arm activity; 24 weeks—approaches pellet with pronate hand; contacts pellet with little or no finger adjustment; 28 weeks—approaches pellet with raking flexion of fingers, without thumb opposition; occasional delayed palmar prehension; 32 weeks—approaches pellet with raking flexion but with increased thumb participation and digital prehension; 40 weeks—approaches with all fingers extended; contacts with index finger and later prehends by drawing index finger against thumb; 52 weeks—approaches and plucks pincerwise with increased deftness." Courtesy of Professor Gesell.

In the field of animal psychology the student may be referred to a splendid study of Kuo. This psychologist studied the development of kittens with respect to their behavior toward rats. The results show that contrary to the popular notion of the inevitable rat killing tendencies of cats the latter will kill, play with, protect, and run away from the rats, depending upon their specific reactional biographies.

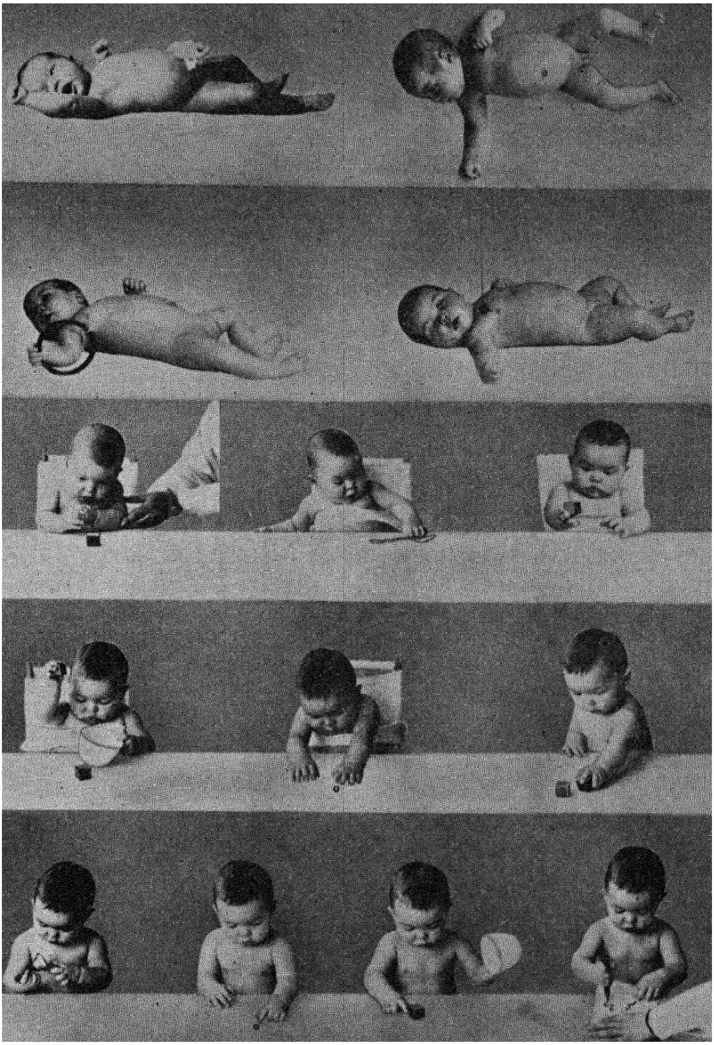


Fig. 14—The growth of infant behavior. From left to right and downward: "A developmental series of photographs of behavior patterns of one baby at fourteen age levels: 1 week, rotates head; 6 weeks, extends arm in tonic neck reflex; 8 weeks, holds ring without regard; 12 weeks, follows small ball; 16 weeks, stares at cube; 20 weeks, contacts spoon; 24 weeks, prehends cube; 28 weeks, bangs cube; 32 weeks, rakes pellet; 36 weeks, pursues second cube; 40 weeks, inspects bell; 44 weeks, plucks pellet; 48 weeks, recovers cube from under cup; 52 weeks, scribbles." From Gesell, *The Guidance of Mental Growth in Infant and Child.* By permission of The Macmillan Co., publishers.

CHAPTER IV

REACTIONAL BIOGRAPHY AND NATIVE BEHAVIOR

From where do geniuses come? Do they step into the world ready made or do they develop after they are born? How can we account for Beethoven and Bach? There are two diametrically opposed answers.

The reactional biography conception implies that all psychological phenomena originate through contacts of organisms with the various objects with which they are inevitably surrounded. This means that all the psychological responses that we ever perform must arise in the course of our behavior history. It means also that all our abilities and capacities must similarly be developed during our individual behavior lives. Thus musicians, actors, thinkers, poets, and inventors are made not born.

Not all psychologists are in sympathy with this conception. Indeed most of them incline toward the native behavior doctrine, according to which individuals are determined to be something, or to do something because of conditions other than the cumulative effect of specific interactions with objects. For these psychologists genius is not the result of behavior experience. Everyone admits as a matter of course that abilities and actions are developed, but they are presumed to be determined by inherited faculties. Development then is considered merely as unfoldment or maturation. Accordingly the proponents of the native behavior theory believe that as the biological organism develops, definite types of action become manifested. Thus at a certain stage of maturity the organism begins to walk, at another stage it begins to talk, etc. And the same thing is presumed to apply to qualities of actions. By practice intelligence and genius are unfolded. So far does the native behavior doctrine go that it is claimed that some reactions are not acquired at all but are inevitably performed nevertheless.

Like all scientific problems the present issue is based upon differing interpretations of facts, and the adoption of different psychological principles. So in view of the fact that our general understanding of the nature of psychological phenomena depends upon how clearly we comprehend the present issue we must unravel some of its details.

I. Two Phases of the Native Behavior Doctrine

The native behavior doctrine really has two distinct phases. The first concerns native behavior proper. The assumption is that human organisms perform responses that they have not acquired. Here the doctrine is concerned directly with action. The second phase has to do with the qualitative nature of psychological organisms. In this phase it is assumed that individuals have certain behavior qualities which they have not acquired in their behavior experience. We will discuss the former phase first.

A. Native Behavior

The simplest sorts of actions as well as the most complex responses have been asserted to be inevitably performed irrespective of concrete surrounding conditions. Thus it is believed that persons natively perform walking, crying, and smiling responses as well as gregarious or social actions. It is likewise assumed that we inevitably fight, collect things, beget children, etc. Thus individuals are presumed to be dominated by or express "impulses," "drives," or "urges" of gregariousness, pugnacity, acquisitiveness, and parenthood.

THE MENTALISTIC VERSION.—Two general forms of this native behavior doctrine are found in psychological literature. The first belongs to the mentalistic tradition. According to this view the "instincts" or "urges" are forces or conditions existing outside the bodily or biological mechanism, but operating upon or in conjunction with the latter.

This form of native behavior conception requires little comment. The idea condemns itself. It is not only impossible to demonstrate the existence of any kind of power or force named "instinct" which makes the bodily mechanisms or the organism as a whole inevitably perform certain kinds of behavior, but it is clear that this conception runs counter to all scientific experience. This doctrine is

obviously only an attempt to account in quick and wholesale fashion for common and frequent behavior by assuming that the latter is caused by psychic forces or faculties. It is not at all surprising therefore that most psychologists who accept this doctrine have attempted to convert "instincts" and "impulses" into bodily processes and thus have turned toward a behavioristic view.

The Behavioristic Version.—Those who adopt the behavioristic attitude regard "impulses" and "instincts" as actual conduct. They translate "instincts" into reflex actions. Clearly the principle used here is that psychological responses are the functioning of biological structures. Psychological phenomena are thus reduced to physiological activities. This view is not inherently false. But can it be justified? If the facts of behavior warrant us in entertaining it then the importance of the specific interactions or organisms with objects is minimized. For no one can doubt that the physiological action of structures requires no further development than the mere evolution of those structures.

Two Problems Emerge

But may we assume that such complicated behavior as gregariousness, fear, play, parenthood, love, or pugnacity is the physiological functioning of structures? It is hardly possible. But even if we do not assume this we still have a problem on our hands. In the first place, it might be said that even if the whole of these complex acts are not native, some parts are. And in the second place, there might be simpler psychological actions which are purely movements or reactions of organs. If so, at least the presumption might be created in favor of the native behavior doctrine. Thus our original problem has become divided into two parts. First, are there any psychological actions which are sheer functioning of structures? And secondly, is there any psychological action that is not developed in interaction with things?

Unacquired Responses

Probably no one would sponsor the proposition that there are unacquired actions among human animals. We must turn, therefore, to the lower organisms. Are there such actions? We must agree that on the surface it would appear so. Simpler animals immediately after birth do perform activities which are complete

and admirably adapt them to their environment. Let us examine some of these facts.

Behavior of the Yucca Moth.—Foremost among such unacquired responses are the activities of the Yucca moth (Pronuba yuccasella). Right after this moth emerges from its chrysalis stage it deposits its eggs by piercing the pistil of a lily flower known as the Spanish bayonet (Yucca filamentosa). After the eggs are thus inserted in the plant tissue the animal dies. When the larvae are hatched from the eggs they find themselves in the seed pod of the flower which has been developing at the same time as the larvae. Thus the latter are well supplied with food as soon as they need it.

The activities of the Yucca moth are only samples of numerous similar facts found throughout the animal world. Another striking instance is that of the worker bee which immediately upon its exit from the hive almost inevitably attacks flowers and collects pollen and nectar. Here we may agree that necessary actions are performed without learning or practice.

Do we have here, however, any evidence of inborn psychological behavior? Are not these infrahuman animal activities non-psychological altogether? Are they not purely physiological? Not physiological of course as the functions of specific organs, but physiological actions of the organism as a whole, in other words, tropismic action.

Tropismic Behavior.—What are tropismic actions? So important are they for psychological theory that we must examine them further.

Tropismic behavior consists of performances directly conditioned by the biological adaptation of the organism to a very particular type of environment.[1] This means in effect that through evolutionary processes animals develop their anatomical structures in an intimate relationship with environing circumstances. The latter naturally include other animals and plants as well as various geographical conditions. Accordingly, organisms develop unique total organizations whose functions constitute the biological activities necessary for their particular environments. The entire organism is put into action or stimulated to respond by the presence

[1] The student must be warned that biologists do not all agree in their definitions of tropisms.

of the different conditions constituting its environment. These phenomena are illustrated in Figs. 15 and 16.

The fundamental fact about tropismic behavior is therefore biological adaptation. Such intricate organic adaptation is exceedingly well illustrated by the Yucca moth. There is an indissoluble relationship between this animal and the lily with which it exists in remarkable partnership. Just as the life and the behavior of the moth depend upon the lily, so the existence of the latter depends upon the moth. Without the action of the moth in fertilizing the lily the latter does not carry on its biological functions. The moth has nothing to do with other plants nor is this plant pollinated by other animals. If we read complex psychological activities into this tropismic behavior of the moth we should do so in the case of the plant also.

Do such facts support a native behavior conception? The answer is no, if we agree that we are not dealing here with psychological actions at all. The general character of the behavior, its perfection, and frequent total miscarriage seem to argue that it is a purely biological affair although it may involve some very elementary psychological factors.[2] Probably no one would deny that the part played by the Yucca plant is entirely biological. Is the more complex action of the moth any different? Perhaps it merely represents a more complicated form of biological evolution.

THE HEREDITY FACTOR OF ACTION.—It is often argued that psychological activities are to a certain extent native on the basis of heredity. The argument proceeds this way. Actions involve biological structures and since these structures are in part determined by heredity, some part of psychological action therefore must be unacquired or inherited. A resumé of an experiment will make this point clear. Carmichael[3] divided some eggs of animals (amblystoma and frogs) into two parts. The first he kept in ordinary tap water and the other he put into water containing an anaesthetic drug called chloretone. Aside from the anaesthetic

[2] No matter how firmly one believes that the behavior of the Yucca moth is complicated with psychological factors it is hardly safe to draw inferences from such phenomena to complicated human behavior.

[3] The development of behavior in vertebrates experimentally removed from external stimulation, *Psych. Rev.*, 1926, 33, 51-58; A further study of the development of behavior in vertebrates experimentally removed from the influence of external stimulation, *Ibid.*, 1927, 34, 34-47; A further experimental study of the development of behavior, *Ibid.*, 1928, 35, 253-260.

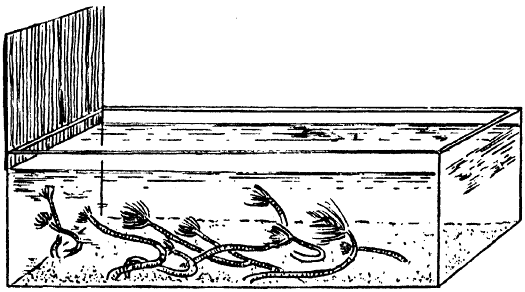


Fig. 15—Tropismic action in marine worms (Spirographis). The worms have turned completely around toward the light after the aquarium was turned around. From Loeb, *The Mechanistic Conception of Life*, Univ. of Chicago Press.

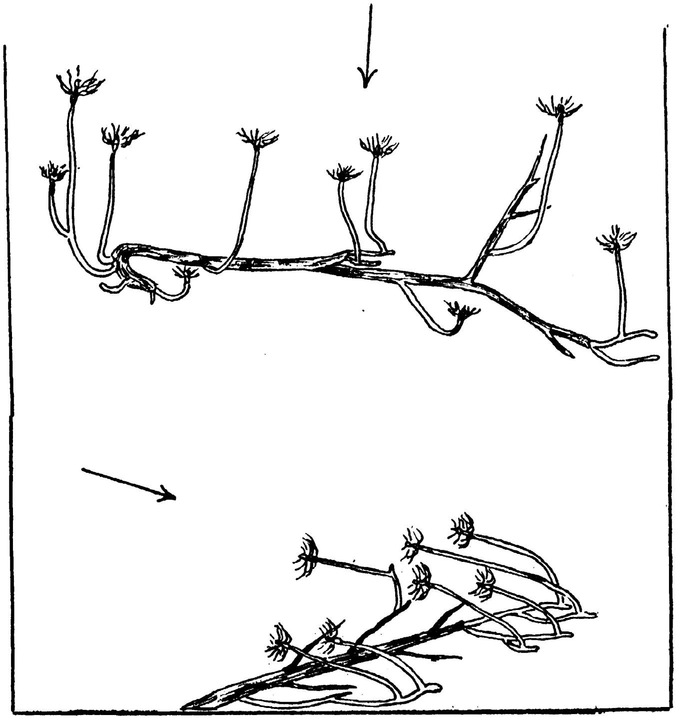


Fig. 16—Eudendrium polyps reacting tropismically. The arrows show the direction of the light. From Loeb, *The Mechanistic Conception of Life*, Univ. of Chicago Press.

both sets of eggs were kept practically under the same conditions. The experimental results were as follows. The control group of eggs, those kept under normal conditions, developed, and when the animals were stimulated by a slender glass rod they began to swim. The drugged eggs likewise developed, a little more slowly, but quite normally. The anaesthetized animals, however, did not respond to the glass rod stimulation. When, however, the anaesthetic was removed they were able after a very short time to swim quite as well as the control animals.

Now what does this experiment show? Carmichael interprets his results as proving that in the development of the swimming mechanism, heredity and environmental factors are interdependent and both are necessary. There seems to be no reason at all to question his conclusion. These experiments undoubtedly show that structures and functions are coordinately developed, and that if nothing interferes with the development of structures their corresponding functions will develop even if they are prevented from operating.

But does this experiment prove that there are unlearned psychological reactions? It does not follow. Even if we overlook the difference between such behavior and the complex actions of human beings we still have the question whether we are dealing here with psychological action at all. Perhaps these swimming reactions are entirely tropismic. Physiological actions we may assume require no learning; there is never any learning problem involved. Therefore, such results do not have any effect upon the problem at hand. In working with such facts we must keep distinct the great differences between physiological and psychological phenomena. We must not be confused by the use of the term behavior for the two kinds of facts.

There is another consideration. We may grant that the swimming performance of the tadpoles and salamanders is in part psychological behavior though we must add that in such performances the operation of biological swimming mechanism is an integral and essential factor. Now in view of the fact that psychological action cannot be developed until after some biological development or maturation is completed, it is hardly safe to assume that there are unacquired psychological actions. Furthermore, despite the fact that we may agree that the animal's organs and their actions are in part inherited it does not seem cogent to argue that psycho-

logical action is in part inherited. This would be like saying that a man who increased a small sum of inherited money into a large fortune had partly inherited the fortune. For scientific purposes such distinctions must be rigidly respected.

Is There any Unacquired Psychological Behavior?

We must turn now to the question whether we can discover genuine psychological behavior which is performed without acquisition in interaction with things. Are there such actions? Prior to the beginning of the present decade most psychologists answered with unhesitating accord that there were. Now the voice of dissent is unmistakable in its firmness. Consequently we must examine some observations to see if they yield such results.

PECKING REACTIONS OF CHICKS.—Breed[4] studied the pecking reactions of newly hatched chicks and found that at first they did not do very well as measured in terms of hitting the grains, picking them up, and swallowing.[5] Then there was a very rapid improvement with a later slowing up of the accuracy with practice until an 84% efficiency was reached. Bird,[6] working with a slightly different feeding technique, found that chicks one day after hatching "began with an initial accuracy of fifteen percent until the sixteenth day by which time they had reached an accuracy of sixty-eight percent."

The study of this readily available activity gives the same general results as any other study of behavior acquisition. Where then is the evidence of inborn behavior? There seems to be none. But those who believe in instincts argue that at least some of the improvement shown was owing to the ripening of an "instinct" rather than to the practice.[7]

Some light is thrown upon this theory by an experiment which Breed performed in collaboration with Shepherd.[8] Instead of

[4] The development of certain instincts and habits in chickens, *Beh. Mon.*, 1911, n. 1.

[5] Hitting and picking up being the precurrent responses to the consummatory reaction of swallowing.

[6] The relative importance of maturation and habit in the development of an instinct, *Ped. Sem.*, 1925, 22, 68-91.

[7] Practice here means the successive contacts with things which provide increased capability of action.

[8] Shepherd and Breed, Maturation and use in the development of an instinct, *J. of An. Beh.*, 1913, 3, 274-285.

allowing young chicks to peck at the grain, they were artificially fed for three, four, and five days, in order to determine whether at the end of the various periods they could feed as efficiently as though they had had some practice. The results showed that though the initial accuracy of the artificially fed chicks was inferior to that of the naturally fed chicks, the former reached and even exceeded in only two days the average accuracy of the latter.[9]

Assume for the moment that no other data are available. What is established by these results? Perhaps we should agree that chicks can do certain things without learning. Would this mean that we have evidence that human individuals perform gregarious, pugnacious, and play behavior without acquiring such reactions in successive behavior contacts with things? Who can believe this? Surely great faith is necessary to draw conclusions from such simple actions and apply them to such complex human behavior. While we must agree whole heartedly that the pecking responses of chicks are psychological, especially in view of the fact that they involve the pattern of striking, seizing, and swallowing, surely they are simple after all. For the most part, such responses involve mainly the operation of anatomical parts. But can the same be said of play, or gregariousness, or parenthood? We cannot but conclude that no case can be made out here.

Now as a matter of fact in the case of the chick reactions, since they are definite psychological responses and not merely tropismic responses, the conception of native behavior will not hold. Let us see how the matter develops. Shepherd and Breed, who believe that the above result indicates a native capacity that needs only to ripen or mature, must still account for the fact that it takes even two days for the "instinct" to ripen. They declare that a given amount of practice is necessary to "smooth the way" for the instinct. This admission of course is fatal, for certainly the condition of performing an activity without any prior contacts with things is not met.

Let it be granted that in the first few days of a chick's life the general biological maturity of the organism has not reached a

[9] Moseley, (The accuracy of the pecking response in chicks, *J. Comp. Psych.*, 1925, 5, 75-97) working with a larger number of animals, failed to obtain such striking improvement right after the forced feeding periods. But it has been suggested that the artificial feeding was responsible for an interference with response acquisition.

point at which the animal can act with its maximum efficiency. There are two points to be considered here. In the first place, as soon as the animal reaches such a high stage of effectiveness it should require no further practice. This is not the case, for a steady increase in efficiency follows for some time.

In the second place, why disregard the conception of practice for the second period and ascribe the results entirely to the "maturing of an instinct?" Watson[10] has keenly and destructively criticized this procedure. But even if we allow ordinary learning practice to have no effect here, is there not a profound confusion of the "maturing of an instinct" with actual biological maturation? Why not say that the animal increases in efficiency because the biological organization, that is to say, the anatomical structures, and their functions which are components of or participants in the psychological responses, becomes more and more mature and hence better fitted for the action in question. This involves no mysterious "instinct." The latter view as we have indicated, of course, would mitigate the force of the native behavior conception, if not completely set it aside.

We must take into consideration other facts also. Bird has pointed out that the improvement of reactions in artificially fed chicks is retarded when they are limited in practicing their pecking responses. Surely this fact does not comport with an instinct conception.

Summing up these facts involved in the pecking reactions of chicks we find that they unmistakably support the reactional biography conception. We find that here as elsewhere, successive contacts with stimulus objects are the indispensable bases for the capacity to perform responses, although as we should expect. the maturation of the organism is an indispensable feature.[11]

Other Behavior.—Similar results have been obtained from the study of other kinds of behavior. For example, when Yerkes and Bloomfield[12] studied mice-killing reactions of kittens they reported a great many actions were being performed which could not be interpreted as native behavior patterns. What they regarded

10 Behavior, 1914, p. 141.

11 The latter, Bird is convinced by his studies, requires only the first few days of the organism's life to have its full effect.

12 Do kittens instinctively kill mice?, *Psych. Bull.*, 1917, 7, 253-263.

as a definite instinct to kill was a complex of actions showing a decided influence of behavior experience.

Stone's[13] work on the sex and maternal behavior of rats is comparable in results. Here, too, the decidedly psychological actions consist of elaborate behavior which in spite of a large component of biological functioning undoubtedly results from an interactional history.

It must be admitted that all of the activities that we have considered can readily be interpreted as native reactions if we but overlook the numerous specific stimulus-response developments which are without doubt factors in the total behavior complex. But it is precisely these specific events which are the important constituents of the total behavior picture.

We must call attention to the possibility that behavior development may be a very rapid process, too rapid in fact to be readily observed. We have already noticed in Chap. 3 that immediately originated responses constitute essential factors in every reactional biography. Much of our learning consists of such behavior development if only we do not arbitrarily define learning as elaborate behavior acquisition which requires a long time.[14] While we should not insist upon calling such rapid and subtle behavior acquisition learning, we must call attention to the fact that at least the resulting behavior is developed or acquired, and not native.

Is Psychological Behavior the Same as Physiological Function?

A study of the native behavior doctrine indicates quite clearly that in part at least it is based upon a confusion of physiological and psychological facts. Those who accept this doctrine apparently fall back upon the argument that native behavior is the sheer functioning of biological structures. It is obviously only in this way that any one could suppose that organisms perform inborn or inherited behavior.

Now it is certainly true that once a species of organism has acquired a certain organ through an evolutionary process this organ

[13] The congenital sexual behavior of the young male albino rat, *J. Com. Psych.*, 1922, 2, 95-153; Preliminary note on the maternal behavior of rats living in parabiosis, *Endocrinology*, 1925, 5, 177-203; Maternal behavior of the albino rat (with Sturman-Hulbe), *J. Comp. Psych.*, 1929, 9, 203-237.

[14] In measuring time here we must take into consideration the relative ratios of behavior acquisition to life cycle in the different animal species.

will perform its particular function by virtue of this evolutionary development. This means to say that the action will occur without any learning by the individual organism. In order to establish the native behavior doctrine we should have to assume that gregariousness, play, and other unlearned activities constitute the sheer functioning of biological structures.

Can anyone possibly believe that specific organs exist for parenthood, gregariousness, acquisitiveness, or pugnacity? Or that the total organization of the human animal has been evolved to carry on such functions? Probably the great error here is to overlook all the myriads of an individual's specific interactions with things which are subsumed under the above classes of actions.[15]

Does the Human Organism Perform Purely Physiological Actions?

Psychological responses are always at the same time biological activities. Furthermore, there is an inevitable relationship between reactional biography and biological life history. But whenever we confuse the two we are in great danger of misinterpreting our facts. We have already seen that psychological phenomena always include biological activity. The latter participate in the former. Let us inquire then whether we can discover in the human organism any sort of behavior which can be regarded as sheerly physiological action.

EARLY INFANT BEHAVIOR.—Since psychological behavior develops upon a foundation of biological action the earliest psychological performances of infants constitute acts just emerging from the physiological state.

At this period the behavior of organisms involves very little discrimination—that is to say, the interactions display very few cumulative results of successive contacts with things. Since such activities merely represent a transition stage in the organism's development from a biological mechanism to a distinctly psychological organism, the particular activities performed constitute little more than the operation of anatomical structures. This situation comprises an incident in the development of individuals and is therefore

[15] It is an extremely important fact that such a term as pugnacity, as well as every other name for supposedly innate behavior, is a class term representing a very large number of varying actions.

a temporary circumstance. Here it must be admitted that psychological behavior is for the most part physiological, but it requires a fecund imagination to cross the vast ocean separating such simple and insignificant reactions from the complicated responses properly termed gregariousness, parenthood, and so forth.

ADULT REFLEX CONDUCT.—To be sure, in the adult we also find simple activities that are to a large degree physiological in character. Touch a hot object accidentally and you jump away from it. As simple as these responses are as a class, even they are not lacking a certain amount of development. But even if we assume that these actions are entirely physiological it would still be a great error to erect upon this slim foundation the gigantic conception that sociability, pugnacity, parenthood, and other complicated responses are native reactions.

How to Distinguish between Psychological Responses and Physiological Functions

Since the distinction between psychological interactions and physiological functions is so important for the settlement of the native behavior problem as well as for the proper understanding of psychological phenomena in general, we must stop to consider some studies of animal learning which emphasize this divergence of facts.

THE FLIGHT OF BIRDS.—Consider how birds learn to fly. Here too for the most part the reaction is a physiological performance. It is mostly the functioning of anatomical structures. We must take into account the wings, the keel formation of the sternum, and other structures adapted for flight. Now in so far as flying consists of wing action, for example, the animal requires no true learning. But since flying also means adjustment of various objects, the flight of birds depends upon flying experience and behavior history. Here while the learning consists primarily of the discovery of the use of wings in connection with surrounding objects, the genesis of the flying behavior in the organism's reactional biography must be indicated.

These suggestions are supported by the observations of Whitman[16] upon the flying of pigeons. He noticed that the young bird

[16] Orthogenetic Evolution in Pigeons, Vol. 3, 1919; The Behavior of Pigeons, ed. by Carr, p. 157.

making its first flight from the cote can be easily caught because the unpracticed flight is very inaccurate and ineffective. The flight of a bird indicates quite distinctly that the psychological responses of the organism are not native in the sense of sheer functions of anatomical structures.

THE SINGING OF BIRDS.—Studies upon the singing of birds show not only the divergence between the total psychological responses and the physiological actions participating in the former, but also the tremendous influence of the objects with which the organism interacts. Several writers have provided evidence that, while because of their anatomico-physiological organization, birds could sing, their songs would not resemble the song of their species until they could interact with members of that group.

By isolating some Baltimore orioles and observing for several years Scott[17] observed that they learned to sing but that the song was not that of the oriole but to a certain extent resembled that of the wren. Again, by putting a young brood of six day old orioles with a couple of adult birds that were reared in isolation, he discovered that they adopted the song of the old birds.

Conradi[18] placed a young English sparrow with canaries and found quite definite influences of their contacts upon the song of the sparrow. In this connection it is interesting to notice the remark of Wallace, the famous naturalist, who writes that "young birds never have the song peculiar to their species if they have not learned it; whereas they acquired very easily the song of almost any other bird with which they are associated."[19] Sanborn[20] has recently pointed out that the trained bull-finch especially acquires its song, though he tentatively holds that some birds inherit their song.

THE SEX BEHAVIOR OF PIGEONS.—The great influence of interactions with objects upon the character of responses is excellently illustrated by some observations upon the sex behavior of pigeons. Whitman[21] reports that a male passenger pigeon which was reared

17 Data on song in birds, *Science,* 1901, 14, 522-26; and 1902, 15, 179-181.

18 Song and call-notes in English sparrows when reared by canaries, *Am. J. Psych.,* 1905, 16, 190-198.

19 Quoted by Dashiell, J. F., The Fundamentals of Objective Psychology, Houghton, Mifflin, 1928, p. 189.

20 Sanborn, H. C., The inheritance of song in birds, *J. Comp. Psych.,* 1932, 13, 345-364.

21 Op. cit.

with ring-doves until he was fully grown was ever ready to mate with any ring-dove but never could be induced to do so with a female of his own species. This bird was kept away from ring-doves for a whole season in order to see if he would mate with a passenger pigeon, but he failed to make any advances to the female of that species. When a ring-dove, however, was seen or heard in the yard he always became attentive.

Now the question arises whether we are not misconstruing the structure-function facts of animal behavior when we use them to support belief in the native behavior of complex human organisms. While it is true that among the very simple animals the close concomitance of biological and psychological behavior makes it possible to assert that the organisms do not have to interact much with their stimulus objects in order to perform adequately adjusting responses, this fact merely indicates the simplicity of the behavior and not its native or inherited character. Furthermore, we must not forget that the higher we go in the animal scale the wider becomes the gulf between biological functions of structures and genuine interactional behavior. Clearly, one must twist facts almost to a breaking point in order to interpret them as opposing the reactional biography conception.

B. *Native Psychological Qualities*

At last we come to the native qualities aspect of the native behavior doctrine. The main contention here is that while the organism must acquire the specific responses it performs, it is born with or endowed with capacities. Thus it is said that while the person must learn arithmetic he is born with the capacity to learn it. Native qualities of all sorts are then ascribed to individuals. Some of these are reputed to be general capacities such as superior or inferior intelligence, while others are regarded as specific abilities or attitudes in a great variety.

Like native reactions, native capacities were originally regarded as mentalistic, but for the most part they are now looked upon as bodily factors and especially neural. Accordingly, those individuals who are regarded as superior in capacity are presumed to possess superior neural mechanisms. We must therefore examine the conception of native capacity as a bodily function. But first we must consider a principle which lies at the basis of this conception—namely, the general notion of potentiality.

POTENTIALITY AS A PSYCHOLOGICAL PRINCIPLE.—My golf is rather expert though many persons can do better than I. What is the objection to saying that I had the capacity to play golf even before I began? Certainly no one can say that I possessed the capacity not to be able to play golf. So far then this notion is innocent of any bad scientific implications, especially if the assertion only means that as a matter of fact I have learned to play golf.

However, just as soon as the term capacity is taken to mean some sort of potentiality existing prior to my taking up the game it is very likely to take on exceedingly sinister aspects. In the first place it may be the cause of our believing anything we like about native qualities. When we forget that we can only assert the existence of capacities after observing the person perform certain actions we might be misled to believe in all sorts of mysterious powers. This makes for bad science. Furthermore, if I am content to believe that I play a good game of golf merely because I had the native capacity to play it, then I am prone to overlook all of the concrete facts that have had a share in the actual process of acquiring the responses that go to make up my game. It is necessary therefore to examine this conception a little more closely.

A scientist can only deal with concrete happenings. Accordingly when he speaks of a potentiality he must really be referring to specific events which have contributed to a certain end result. The potentiality then does not mean what it seems to mean; it really signifies that I am not crippled in any way, that I had the time to devote to this game, that I had the money to buy equipment, and so forth. Now if we take these facts into consideration will they not all tend to fit themselves into a series of happenings which is what we mean by a reactional biography? In this sense potentiality does not support the doctrine of being able to do things without having acquired the specific response involved.

NATIVE CAPACITIES AS BODILY FUNCTIONS.—When we attempt to attach native qualities to bodily or neural factors we at once run into a striking paradox. On the one hand, the conception in question deals with general qualities, but on the other, bodily or neural conditions must perforce be specific. There seems to be no merit in an organic view unless it does deal with specific organs. But here appear some fatal considerations. Item one. There is the complete absence of any biological or neurological evidence of any

psychologically significant differences in the nervous systems of individuals of the same species.[22] As item two, we refer again to the probability that it is an entirely false assumption that psychological phenomena are the functions of specific structures, whether of particular preformed pathways or of the total organism.

Once more, we must refer to the inescapable fact that a psychological response is always a very specific type of interaction. Probably no one would dispute the point when intelligence responses are in question.

The issue therefore is clear. Is it reasonable to suppose that one can be natively equipped to perform responses superior to other persons? Or does it seem more likely that such superiorities, which are indisputably established, are to be accounted for by differences and perhaps advantages in the reactional biographies of individuals?

II. Does the Reactional Biography Conception Favor the Environment against Heredity?

Possibly someone might conclude that the real issue between the native behavior doctrine and the reactional biography conception is that while the former rests on the potency of heredity in psychological phenomena, the latter favors the environment. The first but not the latter part of this statement is true. Those who hold to the native behavior doctrine do believe that psychological capacities are transmissive qualities. But it is not at all the case that those who hold to the reactional biography conception stress environment as over against heredity. This, however, does not mean either that they join those native-behavior psychologists who claim that both heredity and environment together determine human behavior. As we have already pointed out a number of times, psychological conduct is quite a different thing from biological action and the latter is only connected with the former as a participating factor. Accordingly, only to a very limited extent do the facts of heredity contribute to psychological action. They only provide the possibility for the development of such action by conditioning the development of an organism of a particular species.

We may now ask therefore what are the psychological implications of heredity. And first let us observe that heredity can never

[22] But see the very careful study of Davis, R. C., Ability in Social and Racial Classes, Century, 1932.

be regarded as anything but a process whereby organisms maintain certain anatomico-physiological traits during the course of animal reproduction.[23] The essential feature of the process consists of the maintenance by a species or variety of organisms of the stability of its animal organization. Now here is the important point. This stability of the organism is a function in a mathematical sense of the environing circumstances. Heredity then is a purely biological phenomenon and consists of the biological interaction between organisms and surrounding conditions.

The heredity process then has two phases. One is the continuation of the species or variety as over against its environment. This is what we may call the essential transmissive factor of heredity. Here we may properly speak of the likenesses between parents and offspring such that acorns always develop into oaks and not elms. In such interactions as are found in the sprouting and growing of the seed, the environment (soil, climate, etc.) acts as a stabilizing factor.

The second factor of heredity is concerned with the interactions between the developing individual and its envioronmental surroundings. The environment, which includes all the conditions with which the organism is in contact during its intrauterine life and later (for the embryonic period of an organism is only a part of its general development), makes for variations between members of the same species. The interactions with varying environmental factors, of which the metabolic conditions are the primary ones, determine the unique biological characters of individuals. It is among these interactions that we must look for the conditions that determine the development of characteristics that make offspring different from their parents.

The phenomena of heredity then are entirely biological.[24] As we have said, they have only a remote connection with psychological facts. When they do, they are concerned with the maintenance of biological structures and functions. What is the relevancy then of connecting such facts with the capacities of individuals? If capacities are genuine psychological actions then they are not closely connected with hereditary phenomena because psychological phe-

[23] See also Chap. 25.

[24] Those who attempt to work out a theory of psychological heredity upon the statistical basis of resemblances between parents and offspring always overlook the detailed facts of reactional biography.

nomena are not the functions of biological structures. If, on the other hand, they are regarded as abstract potentialities then they have no manner of connection with either biological or psychological phenomena. Since we reject both of these views we do not favor either of the two hereditary theories. No more do we regard the environment as a primary factor in psychology as over against heredity. For psychological stimulation is a very different phenomenon from biological environment.[25]

[25] For a discussion of the differences between psychological stimulation and biological environment see Kantor, An Outline of Social Psychology, Follett, 1929, pp. 251-256, et passim.

CHAPTER V

THE FOUNDATION STAGE OF REACTIONAL BIOGRAPHY

Three Stages of Behavior Development

The psychological life of an individual constitutes a progressive development of different ways of interacting with things. Fundamentally this development depends upon the individual's opportunities to get into contact with objects and persons. These opportunities depend in turn upon biological and human circumstances. The biological conditions include the various maturation processes that we have studied, while the human conditions comprise numerous social and economic circumstances. Obviously the biological conditions begin to operate earlier.

When we take into consideration these two types of influences upon behavior development we can distinguish three fairly definite stages in the evolution of any given reactional biography. Each of these stages, arbitrarily chosen from the great number possible, represents a period when the individual first begins to perform certain types of responses. These three developmental divisions we call (1) the foundation, (2) the basic, and (3) the societal stages.

Foundation or Infantile Stage

All the psychological interactions of the foundation stage depend very definitely upon the biological maturation of the organism. In general, the infantile interactions may be regarded as transitional; that is, they constitute the simple passing over of the organism from pure structure-function (biological) activity to definite historical (psychological) interactions with things. Because of this transitional circumstance, whatever psychological interactions take place at this stage depend for their operation very closely upon the

anatomical structures and their functions. At this period the organism participates in three distinct forms of interaction, the *reflex, random,* and *ecological* types.

Reflex Behavior Segments

WHAT A REFLEX ACTION IS.—The response of the reflex behavior segment we have already seen consists of a single unitary reaction system.[1] The individual merely jumps away from some hot object, or secretes saliva when shown some confection. The response comprises no precurrent behavior of any sort. This simplicity constitutes one of the primary characteristics of the reflex type of interaction. Reflex responses are little more than the operation of a structure-function mechanism, but are nevertheless distinctly differential with respect to particular stimulus objects, since certain specific stimulational functions are required to call them out.

ORIGIN OF REFLEX ACTION.—It is evident from our description that reflex interactions belong to the immediate crigin[2] phase of reactional biography. Such interactions with things presuppose only the existence of a certain anatomical organization. Accordingly some of these responses are acquired by the organism during its intrauterine existence. The early days of infancy, however, constitute the striking acquisitional period, for at this time the individual has very little behavior equipment. It must be observed, however, that there is no time during the course of the individual's reactional biography when he does not acquire reflex forms of behavior.

SPECIFIC CHARACTERISTICS OF REFLEX BEHAVIOR SEGMENTS.—The specific characteristics of reflex behavior segments are normal consequences of their simplicity. Thus a reflex response is highly *organized.* The action of the organism is definite, complete, and appropriate. It follows, too, that such responses are relatively *automatic.* The interaction requires little time for its occurrence and its operation is exceedingly facile. Again, reflexes are *constant* in their operation. They occur always in practically the same way. Finally, since reflexes come so close to being the functioning of structures the organism persists in performing them throughout its reactional history. Consequently the reflex response is *permanent.*

[1] Chap. 2, p. 23.

[2] See Chap. 3, pp. 44 f.

Two Types of Reflex Behavior Segments.—Two distinct types of reflex behavior segments may be distinguished on the basis of the location of the stimulus.

A. Interoceptive reflexes are those in which the organism is interacting with some stimulus object or condition located within its own body cavity. Here the stimulus object is some organic condition, say, of the heart, or other part of the viscera. The interoceptive reflex behavior segments we should expect to be subtle in their operation, and on the whole inapparent both to an observer and the person who performs the action.

B. Exteroceptive reflexes are stimulated by objects and conditions outside of the organism. Winking the eyes, dodging when a missile is thrown, and jerking away from a hot object illustrate this type. Here, of course, there is a more marked interaction and one that can be more readily observed. The interactional principle, however, is the same in both cases.

Reflex behavior of both types includes reaction systems which are either localized or diffused. The act of automatically brushing a fly off one's forehead is a relatively localized action as compared with the act of jumping when someone unexpectedly explodes an air-filled paper bag at one's ear.

Psychological and Physiological Reflexes.—A great deal of misunderstanding has crept into psychology because of the confusion of the reflex type of psychological interaction and the physiological action which bears the same name. It is quite clear why this confusion has arisen since the psychological reflex response has its basis in the biological character of the organism. Also, in addition, the stimulus functions calling out the reflex reaction are of the universal type; therefore the reflex response comes pretty close to physiological behavior.

A physiological reflex, however, consists merely of the operation of some particular organ, say a gland, or a muscle. This is purely a structure-function event. The physiological stimulus consequently is anything which sets this structure or organ into operation. In this connection we quote the definition of the term stimulus as given by a physiologist—namely, "any change in the environment of an excitable tissue, which, if sufficiently intense, will excite the tissue, will cause it to display a characteristic activity."[3]

[3] Adrian, E. D., The Basis of Sensation, Norton, 1928, p. 18.

When a physiologist studies reflex action he works primarily with tissue preparations. He makes his observations upon isolated muscles and nerve tissue with which he can experiment. This experimental procedure thus introduces artificial factors from the standpoint of both physiological, and psychological happenings. The point is that in the living organism, and especially if it is of the human species, even the purely physiological reflexes must be looked upon as acts of the total organism, since no particular organs operate in absolute isolation. The general description of reflexes, therefore, as the function of structures put into operation, we take to be entirely exact for purely biological purposes.

When we come to psychological reflexes, however, we must insist upon an interactional instead of a structure-function description. Hence we stress the point that the psychological reflex behavior segment involves on the response side the activity of the whole organism, in spite of the fact that in our everyday descriptions we tend to localize the action in some particular organ or part. For instance, in describing the secretion reflex mentioned we say that "the mouth waters."

On the stimulus side we must take note of the actual stimulus function involved. As we expect, of course, these functions inhere in things and conditions which are very simple as compared with stimulus objects of other types of behavior segments.

When we respect the distinction just made between psychological and physiological reflexes we can immediately discern the fallacy in the idea that (a) a reflex action is the operation of a sensory-motor arc, even when this is presumed to include muscle movement, and (b) that a reflex action is a bodily movement without a psychic component as compared with so-called voluntary reactions which do involve psychic components. The former of these ideas has been fostered by the behavioristic psychologists, while both have found a place in mentalistic psychological systems.

Some Illustrative Reflex Actions.—Is yawning a biological or a psychological action? This is a pertinent question, for, since even biological responses consist of the total action of organisms, such conventional names as yawning, sneezing, groaning, and swallowing may stand for either purely physiological reflexes or definite psychological actions. It has already been suggested that the human organism probably performs few if any exclusively physio-

logical reflexes. We should only look for such biological actions in the isolated heart beat, alimentary contractions, breathing movements, and perhaps a few others.

In order to emphasize the difference between physiological and psychological responses we have drawn up two lists of which the members of one might, while the members of the other cannot, be purely physiological.

A. Reflexes which might be physiological actions, especially in infancy.

Pupillary contraction	Twitching	Screaming
Pulling hand away from hot or cold object	Excreting	Vomiting
Trembling	Winking	Sucking
Shivering	Knee-jerk	Gasping
Starting	Squirming	Salivating
	Screeching	

B. Reflexes[4] *which are distinctly psychological, especially in adults.*

Yawning	Great variety of simple tics, head turning, shoulder shrugging, hand contracting, etc.	Scowling
Tickle reflexes	Sex responses	Wincing
Smiling	Groaning	Stretching
Laughing	Sighing	Dodging
Swallowing	Blushing	Starting
Withdrawing hand from hot or cold object	Paling	Coughing
Jumping out of danger		Vomiting
Facial gesture		

THE CONDITIONING OF REFLEXES.—A very striking phenomenon in the field of reflex action, and one which demonstrates its psychological character, is the process of conditioning.

PAVLOV'S EXPERIMENT.—The present interest in the conditioned reflex dates from the publication of the experiments by Pavlov on the conditioning of the salivary reflexes of dogs. The experiment consists essentially of rigidly controlling an old observation that a hungry dog will rapidly secrete saliva when meat is

[4] The student of psychology will do well to notice that what are called reflexes in many cases are not simple reflexes at all but really habit responses.

placed somewhere within sight or smell.[5] Pavlov inserted a cannula in the cheek of a dog and devised a technique whereby he could measure the amount and quality of salivary fluid thus secreted. The apparatus is indicated in Fig. 17. In the experiment the salivary secretory response, which is originally connected with the food stimulus, is later connected with a buzzer sound which has been presented along with the food. The reflex action is then described

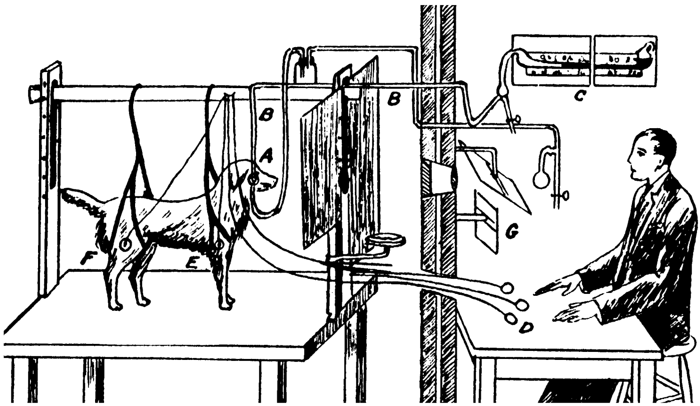


Fig. 17—Pavlov's conditioned reflex experiment. Stimulation of the dog by experimenter in observation chamber results in the flow of saliva which is conducted through a tube A in the dog's cheek and conveyed through tube B to the registering apparatus C. Here the saliva is measured and from this apparatus the salivary fluid can be removed for chemical analysis. D indicates three controls. By means of one of these acid can be placed in the animal's mouth and by means of the other two the foreleg and the hind leg can be mechanically stimulated as at the points E and F. The experimenter's observation chamber is separated from the animal's section to prevent distracting stimuli. The experimenter can observe the animal through periscope G. From Evans, *Recent Advances in Physiology*, Churchill, publishers.

as conditioned with respect to the bell. The organism reacts now to the accessory stimulus (bell) as well as to the primary stimulus (food).

Pavlov and his coworkers discovered that more than one accessory stimulus could be connected with a response. For example, in one experiment the salivary reaction was connected with a metronome sound, a buzzer, and a black square. In Pavlov's terminology, the first conditioning process results in a conditioned reflex

[5] Taine in his book "On Intelligence" written in 1869 mentions this as a method of physiologists to obtain saliva for experimental purposes.

of the first order; an additional conditioning gives a reflex of the second order. The third order according to this experimenter is the highest level obtainable.[6]

CASON'S EXPERIMENTS.—Cason performed conditioned reflex experiments on human subjects, using the pupillary,[7] and eyelid or winking reflexes.[8] In the winking experiment winking was effected by stimulation from an electrode placed just under the right eye of the subject. The conditioning stimulus was a sharp sudden sound of low intensity. The latter at first did not call out the winking reflex. After a number of trials in which the winking response was simultaneously stimulated with the sound stimulus, the latter alone produced the reaction. The conditioned eyelid response was in many cases found to be much faster than could be produced by normal stimulation.

OTHER CONDITIONED REACTION EXPERIMENTS.—The conditioned reflex phenomenon has taken psychologists by storm. Many workers have performed experiments on a number of different kinds of animals and upon a large variety of responses. Besides the large amount of work of Pavlov and his pupils on secretory reactions there are numerous studies by Bechterev and his students on various movements. Watson has also studied the retraction of the finger as well as the conditioning of fear responses. The whole subject of conditioned reflexes is excellently summed up to the year 1925 by Cason.[9]

THE SIGNIFICANCE OF THE CONDITIONED REFLEX EXPERIMENT.—In the opinion of the writer the significance of the conditioned reflex experiment lies precisely in the demonstration it affords of how stimulus and response interconnections are organized. What happens in the case of the reflex occurs also in all sorts of responses. The conditioning process consists essentially of endowing an object with a particular kind of stimulus function by way of performing a specific sort of response to it. It goes without saying that the

[6] Pavlov, I. P., Conditioned Reflexes, trans. by Anrep, Oxford U. Press, 1927, Lec. 3.

[7] The conditioned pupillary reaction, *J. Ex. Psych.*, 1922, 5, 153-196.

[8] The conditioned eyelid reaction, *J. Ex. Psych.*, 1922, 5, 108-146.

[9] The conditioned reflex or conditioned response as a common activity of living organisms, *Psych. Bull.*, 1925, 22, 445-472.

conditioning process presupposes certain definite interactional conditions.

THE CIRCUMSTANCES NECESSARY FOR CONDITIONING REACTIONS.—In the first place, the kind of reactions that can be conditioned depends upon the type of organism in question and also its previous reactional history. There are also important immediate circumstances involved in the contact between the organism and the stimulus object. To condition a secretory reflex in a dog the animal must be hungry. Its health is also a primary consideration. Furthermore, the animal must be sensitive to the stimulating conditions.

On the stimulus side the object must be clearly discernible. Thus the sound must be strong enough to be heard. Also it must be kept distinct from other sounds which have a distracting effect upon the conditioning procedure. And finally, the contact between the reaction and the stimulus must be kept up or repeated a sufficient number of times.

How long the conditioning lasts also depends upon certain specific circumstances. If the conditioned stimulus is presented a number of times without the food reaction being performed then the conditioned response is gradually extinguished. Thus by separating the stimulus and response their functional connection is broken.

As a general phenomenon, the conditioning process has been known and employed for a long time. Benvenuto Cellini tells us in his Autobiography that when he was five years of age (1505) his father called him and his sister to see something which he pointed out to them in the fire before which he was sitting. The father then gave Benvenuto a sound box on the ears which made the boy cry bitterly. Thereupon the father soothed his son with kind words, saying, "My dear little fellow, I did not hurt you for any harm you had done, but only that you might remember that the lizard in the fire there is a salamander, which never has been seen for certainty by anyone before."

Reflex conditioning then we may take to be only one of the many kinds of stimulus-response connections through contact of organisms with stimulus objects. If this is true then we must be solemnly warned against the fallacy of thinking that reflex conditioning is the basis for all psychological processes. The reflex type of response is only one of a great many types of behavior.

Random Movement Behavior Segments

Random Behavior is Transitional.—As historical phenomena psychological actions must have a beginning somewhere. We have already learned that psychological behavior grows out of biological action. But it is obvious that our complex psychological actions can only develop gradually and through a slow process. It is easy enough to assume then that there must be some primordial form of behavior, that is to say, behavior that is on the borderline between biological and psychological action. It is the random movements of infancy that constitute this transitional action. On the one hand they are deeply rooted in biological action, while on the other they look forward to full-fledged psychological behavior.

As transitional responses, random movements are connected with biological phenomena in two ways. First, they depend upon the structural differentiation of the organism. Not until the organism has developed its structures and functions can these psychological activities begin. In the second place, random behavior parallels biological maturation. During the period that the organism is still so immature as not to be able to adjust itself definitely to particular objects, its psychological action is random. There is as yet only the barest emergence of genuinely psychological behavior.

How Random Behavior Segments Operate.—Random segments constitute uncoordinated contacts with things. The responses are ineffective and hardly show the promise in them that will later blossom forth. As we observe the very young infant we find that its behavior is not integrated with stimuli. Its actions therefore are much more diffuse than they need be. We may say that it performs multiple responses and that objects have indifferent stimulus functions for it. An infant barely touched upon some part of its anatomy shifts and squirms in an attempt to avoid contact with the stimulating object.

Random movements derive their name, therefore, from the fact that they are not thoroughly organized activities. They are performed by organisms not yet sufficiently mature to respond in a way that is definite enough to achieve a satisfactory adjustment. Since these early activities are only to a very slight extent differential with respect to the stimulus, it would seem at first glance that they hardly deserve the name of psychological conduct.

The Importance of Random Movements.—Two important considerations argue strongly that we must accord random movements a prominent place in psychological descriptions. In the first place, we must regard them as the raw materials of much of the organism's behavior. It is these partially organized activities which become tightly integrated into very definite reaction systems. To leave these out of account is like overlooking all the experiences of the apprentice years of an expert craftsman when accounting for his skill. Without these random movements the organism could have no organized behavior at all.

But there is something more important still. It is not enough to think of random movements as merely the raw materials of behavior. They represent in a genuine way the beginnings of complex actions. Let us remember that complex psychological conduct consists always of the integrating of simpler movements. Accordingly it is such random contacts of the organism with the conditions around it that mark the beginnings of very definite differential psychological reaction systems. During these contacts the organism's random behavior becomes closely connected with specific stimulus functions of objects and later constitutes full-fledged adjustments. The organism is then prepared to have these adjustment acts integrate further into more complex adaptations when it has additional opportunities for contacts with their stimulus objects.

Random Behavior and Tropisms.—We may learn a great deal about random responses by comparing them with the tropismic actions of animals.

As we have seen (Chap. 4), tropisms are physiological activities which are not localizable in any particular organ or structure but constitute the operation of the organism as a whole. Now because tropismic action involves merely the functioning of the organism's structures on the basis of its physico-chemical properties, it operates in an absolutely organized and invariable manner. The biological stimulus with which the organism interacts merely puts into operation these structures and their underlying biochemical properties.

Not so in the case of psychological action. The psychological behavior of the organism is unorganized until it is definitely integrated through a specific interconnection with a stimulus function. But even after the integration takes place, the activity is less auto-

matic and machine-like because it is after all a kind of adaptation to the stimulus object or condition rather than the activity of organs possessing certain biochemical properties.

Because of these differences it is obvious why we cannot demonstrate tropisms in a human animal. For illustrations we must go back to simpler biological forms, as we have indicated in Chap. 4.

Ecological[10] Behavior Segments

When Does Ecological Behavior Begin?—Ecological behavior segments presuppose that the organism is fairly complete as far as its biological equipment goes. Its head, trunk, and limbs are well formed as well as the special organs such as the eyes, ears, etc. Now it is a question of developing such activities as will relate the individual to his ecological circumstances. By the latter we mean all the things, conditions, and persons which surround him or which constitute his biological environment. Ecological behavior segments may be defined as elementary forms of differential reactions to things based primarily upon the character of those objects.

Ecological Behavior Segments are Acts of Discovery.—When the organism first comes into contact with things it finds out what they are like. It discerns that things are red, blue, sweet, bitter, thin, warm, heavy, thick, or light, etc. Furthermore, the individual discovers that some red things are brighter than others, some sweet things sweeter than others. Again, he makes the discovery that some things are red and blue on their different sides, or that milk is white, warm, and sweet, while things like lemons are yellow and sour. Other objects make loud, shrill, or lower sounds. Some roses are sweet-smelling and red, while others have different mixtures of qualities. Certain chrysanthemums are yellow and faintly odorous, while others are not.

Besides finding out the qualities of things the individual also finds out what he can do with them. Round objects can be rolled, but not blocks. Thin things can be grasped and seized, but not thick ones. Only some things can be broken and put together. In other words, the organism discovers the possibilities and limits of its structural makeup when pitted against other objects. Thus

10 Like the terms stimulus and response, among others, this term is directly borrowed from biology. The student of psychology will therefore observe meticulously the differences in the use of all these terms in the different sciences.

close things can be reached, but not those farther away. Things fixed cannot be moved, shaken, or manipulated, but objects that are unattached can be handled, kicked, and thrown. Also the infant finds that crying or vocalizing does or does not bring persons and their ministrations.

Again, through such interactions as we have indicated the individual discovers what things can do to him. Here we have the beginnings of wisdom as to what objects are harmful or not, what things produce pleasant or unpleasant effects, and what kind of objects excite and ruffle one. At this period, of course, the acquaintanceship with objects is of the most elementary and rudimentary form.

Ecological Discoveries Constitute Behavior Acquisitions.—Many of the discovery reactions remain with the individual as definite behavior equipment. Although these early reactions to the qualities of surrounding objects are novel, having never occurred before, they are complete actions, and ever afterwards constitute definite modes of adaptation to those objects. The acquisition of reactional equipment through the first contact with the qualities of things thus belongs to the immediate form of behavior development to which we have already referred on p. 44.

Naturally not all reactions that are first performed as ecological discoveries are of the immediately acquired type. Some are built up by the integration of random movements. When this is the case such reactions themselves become integrated into larger forms of responses.

The fact that so many ecological discovery responses result in permanent behavior equipment should not mislead us to think that they all do. Some of these reactions are occasional and fleeting and consequently play no part in the organism's development of capacities for handling or otherwise responding to things.

Table of Ecological Discoveries.—When the infant begins to explore his world he naturally discovers it to be full of many kinds of objects. In order to remind us of the innumerable ecological activities the organism performs, we have constructed a table indicating some of the qualities and conditions of the things with which the organism interacts during the foundation or infantile stage.

A. Qualities of Things (including the organism).[11]

Colors	Odors	Darkness
Sounds	Lightness	Brightness
Shapes	Sheen	Light
Temperature	Dullness	Shade
Pressures	Wetness	Hunger
Massiveness	Dampness	Thirst
Heaviness	Smoothness or roughness	Comfortable and uncomfortable qualities of blankets, clothing, etc.
Sizes	Stickiness	
Tastes		

B. Conditions of Things.

Solid	Mobility	Fragility
Liquid	Opacity	Transparency
Gas	Stability	Malleability

C. What Things Can Do to the Individual and Others.

Strike him	Make him drowsy	Sicken him
Anger him	Hurt or injure him	Shock him (electric wire)
Make him dizzy	Pain him	Push him
Make him blush	Scratch him	Keep him awake

D. Possibilities of Things and Persons.

Dependability (come when called, run when approached, etc.)
Resistance
Change (from solid to liquid, etc.)
Appearance and
Disappearance

ECOLOGICAL DISCOVERIES DIFFER WITH INDIVIDUALS.—Do all individuals undergo a uniform process of psychological discovery? In other words, in our early behavior development do we all have the same experiences? Certainly not. To find out what ecological discoveries any particular individual makes we must study that individual. It is obvious that one may have a great many more contacts with things and consequently discover more about them than others will. Our table of discoveries therefore represents only a sample summary of some of the qualities of things. Clearly it is not the record of discoveries made by any specific organism.

[11] It is some of these qualities of things which the mentalistic psychologist describes subjectively as sensations.

Similarly, the time when such discoveries are made differs. Some of the qualities in our list will not be met with by some organisms in the early infancy stage of their reactional biographies, but only at some later time. In such matters individuals differ considerably. We might add that the number of things any particular person discovers and the time he discovers them depend directly upon the opportunities for contact with such objects that the adults in charge provide.

ECOLOGICAL DISCOVERY AND SOPHISTICATED ANALYSIS.—The infant's early attempts to get acquainted with its elementary environmental surroundings must not be confused with the adult's sophisticated analysis of things. For example, theoretically speaking it is possible for the infant in its early development to discriminate as many as fifty thousand color qualities of things. The chances are, however, that until it acquires the linguistic tool of naming qualities its range is in practice seriously limited. This limitation, however, is a very different thing from the statement that there are only four simple color qualities—namely, red, green, blue and yellow, or six, if black and white are added. This statement is, of course, based upon the fact that when you mix pigments or lights you need only three, four, or six to match any given color, or as some put it, these six are qualitatively irreducible. Furthermore, it is improper to confuse the infant's growing acquaintance with the actual colors of objects with the analysis of the abstracted colors of scientific description.

Similarly it is not correct to say that the infant world contains only four tastes—sour, sweet, salt, and bitter. These are illegitimate abstractions from the standpoint of interactional psychology. Although it is true that we can compound a color or taste quality from two or more simple qualities, this fact does not reduce the number of discoveries of the organism. From the interactional standpoint each color, taste, or smell quality of a thing must be regarded as in itself a unique quality.

ECOLOGICAL BEHAVIOR AND BIOLOGICAL ADAPTATION.—Although psychological reflexes are decidedly not the same as the purely physiological actions bearing the same name, still we were able to trace a connection between them. As we have seen, the former are developed out of the latter. The same sort of connection can be traced between ecological behavior and the biological phenomenon of organic adaptation.

What is organic adaptation? It is a condition of interconnection between organisms and their environment which tends toward the preservation of the former. It consists of two phases. The first is a relationship based upon evolutionary development, such that an organism with a particular structural and functional organization has in its environment certain conditions or other organisms which act upon it to keep it alive. An example of a simple form of such biological adaptation is the lichen. Here two organisms have evolved in such a way as to be excellently adapted to each other. Similarly, all animal organisms have evolved in such fashion as to be dependent upon green plants and are thus able to exist only when adapted to such plants. Lung-breathing animals cannot survive without being in contact with oxygen-containing air. Now to a certain extent ecological behavior is based upon such organic adaptation. For, the organization of the individual, its receptors, skin, and in fact all its structures depend upon its being surrounded by milieux favorable for its existence.

The second phase of organic adaptation consists of adjustments to things not so much on the basis of very definite structures, but rather upon the exigencies of organic existence. What color the chameleon assumes depends upon the kinds of things with which it is in contact. The movement of animals away from seared and toward green plants illustrates this phase also. We may say that here the exigencies of life condition how the organism's structures taken as a whole will operate. Biological adaptation of this type has in it the rudiments of psychological action.

Ecological behavior of the psychological type may be regarded as rooted in both these forms of organic adaptation. But we can, of course, point to an enormous difference between ecological behavior of the biological and psychological types. In the latter the interactions are differential with respect to the qualities of things; also they are not mere interchanges of conditions making for growth and preservation. To a great extent the psychological activities of the ecological type have nothing to do with preservation. Rather, it is a question of the organism becoming acquainted with its surroundings, learning what kinds of things exist, and how to handle them.

Summary of the Foundation Stage

The significance of the foundation stage of reactional biography is that here for the first time organisms begin to perform psycho-

logical conduct. While obviously all psychological behavior is built up around a core of biological phenomena, it is only in these simple and early activities that the biological factors are so prominent. Foundation behavior displays its dependence up (a) the maturation of the biological organization of the organism, (b) the exercise of its structures and functions, and (c) the general adaptation of organisms to environmental or ecological conditions.

CHAPTER VI

THE BASIC STAGE OF REACTIONAL BIOGRAPHY

Basic Behavior is Distinctly Psychological

Mrs. X notices that her very young infant persists in performing decidedly annoying behavior. No matter how often she picks up the rattle the infant throws it out of the perambulator. Fond mother though she is, she hesitates to say that her child is already wise enough to torment her deliberately. But there is certainly no question that this is a distinctly psychological response. Notice how specific it is with respect to the rattle and the perambulator. Furthermore, it is manifest that the infant has built up this behavior as a consequence of certain definite conditions, the presence of a rattle, some place from which to throw it, and an indulgent parent or nurse.

When the infant first begins to perform actions of this sort we say it has reached the basic stage of its reactional biography. At this period the individual begins to attain a distinctly psychological personality and to perform definite psychological activities. What are the behavior changes taking place here?

Let us be reminded once more that the early psychological development of the infant consists of a gradual progression away from the biological form of action. Thus, although psychological reactions are always the actions of biological organisms, they are quite independent of the biological make-up of the individual. This means to say that given a particular biological organism it can under certain conditions build up a set of psychological responses that will vary tremendously from that which it builds up under other behavior auspices. The same biological individual can develop psychologically in various ways throughout an infinite series.

While the structures of an individual constitute parts of every total act he performs, they do not, in the case of the distinctly psy-

chological behavior which begins in the basic stage, condition its occurrence or determine its detailed character. The responses of the organism are too complicated now. Let us turn once more to the facts of speech. When the organism speaks, its structures are all operating, but these structures do not at all determine what the person says, nor to any considerable extent how he says it. Speaking can be analyzed into a psychological adaptation to things and persons as when the child says "I want milk," and also into a series of sound making acts which are the physiological participants in that act. It is the latter only that are affected by the biological structures.

Thus the pitch differences of male and female voices are determined by the structures of the vocal apparatus, but only the physiological components of speech are affected. Speech is a great deal more than mere making of sounds. With the same organic structure, the individual can say innumerable things in any language.

Illustrations like this may be multiplied *ad libitum.* Would any one say that any given individual could not, as the biological organism he is, have developed an entirely different sort of likes and dislikes, knowledge or skill, if only his interactional circumstances had been different?

Basic Behavior Develops in Early Infancy

The basic stage of psychological development proceeds as a parallel development with the individual's biological maturation. Basic activities begin in infancy and early childhood. The parallelism is greater, of course, when the organism is very young. Accordingly most of the basic behavior is developed long before the individual reaches early youth. It happens, therefore, that the basic reactions are among the most fundamental of the organism's psychological equipment. Upon them as a basis are developed the great mass of psychological responses which constitute the individual's behavior patterns. Unless the person becomes wholly reformed we have here the substructure of his future character and intelligence.

Much Basic Behavior is Equipmental

To Jesuit teachers has long been attributed the claim that if they can have charge of a child's first seven years of schooling, the

effect they will produce will be ineradicable. Whether or not the attribution is correct, the claim is based upon solid fact. The secret, of course, is that many of the basic reactions become permanent parts of the person's behavior equipment. After the individual has developed certain ways of interacting with things his later contacts with those objects result in reperforming the same reactions.

This equipmental development begins long before school age, however. From the very earliest days of its life the organism keeps building up reactions that remain as characteristic traits. Indeed, some of the most typical behavior traits are developed through such subtle and unobserved interactions that they seem inevitable and quite ineradicable. When and where did this child acquire his particular temperamental responses, his obstinancy, and his kindliness? Only when we carefully observe the detailed course of the individual's interactions can we discover the growth of such basic equipment. When we do so we can readily appreciate the subtle influences of the parents and other persons with whom the child is in contact.

The equipmental fixity of basic behavior is exceedingly well illustrated in the behavior problems of children. Much of the difficulty and misery of parental care arises from the fact that parents either do not know how to control the behavior development of their children or are negligent in supervising their character development. The results are often very bad. After the children acquire responses of willfulness, disobedience, and destruction the parents are at a loss how to manage them. When the early basic behavior does not conform to the expectations and desires of parents or social standards, then the troubles of the problem-child arise.

Students of abnormal psychology have frequently been very successful in tracing back adult abnormalities to behavior fixities in infancy and early childhood. Such facts amply illustrate the general process of behavior and character development during the reactional history of the individual.

Two Factors Making for Permanence of Basic Behavior

Aside from the fact that basic behavior is developed in the person's early life when there are no competitive responses to interfere with their thorough establishment, there is another condition mak-

ing for their permanence. Basic reactions fit into the behavior scheme of the individual's existence. The intimate details of every particular organism call for and foster certain types of behavior. Since the individual is inevitably a member of a family and community there are certain psychological activities and characteristics that are prerequisite for living with other people and harmoniously fitting into a human group. His skills, language, knowledge, and beliefs must conform to the human environment just as his biological and physical interactions must conform to natural conditions.

Not only is an infant predestined to pass through a certain type of psychological development but the cultural stability of his community guarantees the permanence of the results. It is decreed that a child born into a Euro-American civilization must go to school and learn to read, write, and calculate, while the child of a simpler culture must learn to endure and approve the tortures of tribal initiation. Each in his own way must dovetail into his human situation. Not until he moves into a different human setting can these basic responses be eradicated.

Basic Interactions are Mostly Humanistic

Generally speaking the organism in the foundation stage exists in what is primarily a natural world. With the beginning of the basic period development, conditions are different. By contrast the individual is now interacting with things under the influence of persons. His behavior is accordingly very much affected by the various humanistic milieux in which he finds himself. To illustrate, the infant does not merely see a cat or a dog, but objects called by certain names and to which one does or does not do certain things. Similarly, the individual interacts with things by liking or disliking them, by thinking or believing them to be pretty or ugly, harmful or beneficial, throughout a great range of actions. The result of such interactions with things is that natural objects are to a great extent responded to on the basis of attributed properties.

A word concerning attributed properties. These consist of qualities which belong to things because individuals or groups of people react to them in a certain way. In other words, in basic behavior it is not a matter of discerning merely the redness or hardness of an apple, but whether or not it may or may not be eaten or appropriated without permission. We must add at once that the individual himself can attribute properties to things. It

would be surprising in the extreme if such superactive, explorative organisms as infants, would not through the results of their contacts with things endow them with unique properties beyond those which nature has given them.

The emphasis upon the human factor in the basic stage of reactional biography is justified by the fact that in the childhood stage of the individual, he is almost entirely in the hands of his elders. Most of his behavior is imposed upon him and, of course, reflects the social status of the parents. The life of a child is just one long series of do's and don'ts. In the meantime, the individual develops innumerable responses which we describe as skills, manners, abilities, prejudices, and ideas.

Basic Behavior Reflects Family Traits

The persons with whom the infant is in first contact are the members of his family. The direct auspices of basic behavior, therefore, are the circumstances of family life. It follows, then, that the psychological nature of the individual definitely mirrors the kinds of objects found in his particular family and correlates highly with the activities of the family members. In other words, the kinds of abilities, beliefs, attitudes, speech, likes, and dislikes of the individual definitely represent the psychological status and conditions of the family in which they are developed. Study a child thoroughly and you understand the parents.

Basic Behavior Makes for Individuality

The relative independence of the individual's action with respect to his biological make-up leads to individuality. When behavior depends upon the biological structure of organisms, the behavior of all human individuals must necessarily be practically the same. When this is not the case, however, there are all types of possibilities for individual variation. From this it follows that basic behavior marks the beginning of differences between persons. This stage of reactional biography initiates the significant beginnings of psychological personality. Individuals develop different likes and dislikes, different skills and abilities, although their biological organization is all the same so far as capacities for developing these activities are concerned.

Contributing to this psychological individuation of organisms are the infinite variations among people and the things they possess.

Even children of the same family come into contact with persons of different sex, each with different attitudes, capacities, and interests. The child thus may incline toward one or the other parent, toward both, or neither. Meantime, he is acquiring reactions of all sorts. Again, the numerous articles and techniques making up the home also offer great scope for uniqueness of reactional biography.

In this stage of development, too, begins the contact of the child with other children. Because these playmates come from different home situations, interactions with them constitute a further source of behavior variation and general behavior individuation.

Some Typical Responses of the Basic Stage

Basic behavior constitutes responses to every possible type of thing, person, or event and pervades every domain of conduct. In range it extends from elementary maintenance responses to the most elaborate creative conduct. Basic behavior includes skills, abilities, manners, as well as all sorts of attitudes and beliefs.

ADAPTATION RESPONSES.[1] Among the very first responses that the infant develops are numerous postures, balancing acts, and movements. The acquisition of such equipment operates in organizing the individual as a part of his general surroundings. Thus elementary balancing movements lead to sitting up responses, then to creeping and finally walking. As such serial actions develop they become less dependent upon the biological nature of the organism and increasingly take on the character dictated by the surrounding objects. Thus the way the infant walks or eats becomes more and more colored by the interactional conditions present. It is in this manner that the organism develops his handedness. Some things must be done with the right hand, some with the left, and others with both.

PROTECTIVE RESPONSES.—All the world is a stage, set full of harmful and offensive objects. Some of these things really are injurious, but most of them are only thought to be so. As a matter of course, therefore, much of the basic behavior development consists of building up activities which serve as protective

[1] These terms are, of course, entirely arbitrary and represent only the interpretations of the observer.

reactions. Through the influence of parents or nurses the infant masters the art of avoiding dangerous objects. He learns to hide, or to strike, kick, and otherwise save himself from persons, things, and animals which might injure him. By the same token the infant endows objects and situations with qualities of disgust and annoyance. Even after this period of contact he performs typical specific responses to these things. Worms are drawn away from and the nose is turned up in the presence of dirty things.

MANIPULATIVE AND CONSTRUCTIVE RESPONSES.—Students of South African native tribes have observed the great aptitude for constructiveness in Kafir children. Thus Kidd writes[2] "no farmer's

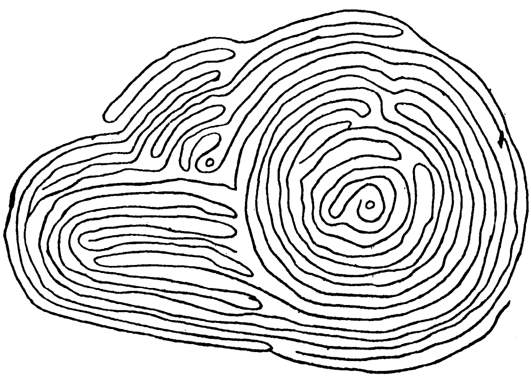


Fig. 18—Specimen labyrinth used in Zulu games. From Kidd, *The Essential Kaffir,* by permission of The Macmillan Co., publishers.

boy in England could make such excellent bird-traps at the age of three as the Kafir child can." The ability to make such elaborate contrivances the children develop in situations where the parents are experts at making snares and traps, and where they must find an occupation while protecting the crops from the depredations of birds and other animals.

Constructive behavior of various types is built up by children of every human society. Some constructive behavior requires the manipulation of materials, while other consists mainly of the individual's configurational movements. An illustration of the former is supplied by the complex labyrinth constructions of the Kafirs. (Fig. 18.)[3]

2 Savage Childhood, 1906, p. 119.

3 Kidd, D., The Essential Kafir, 1904, p. 339.

An English writer in describing a unique sail-fitted caique which Turkish boatmen use to discharge cargo from steamers, says, "A little Turkish boy was very smart in handling one of these craft; in England he would have been barely out of the infant's department."[4] This incident illustrates the early acquisition of complex, manipulative responses when conditions make it possible.

In our complex society, homes are always full of things. Many of these objects can be handled, rearranged, taken apart and more or less well put together again. By means of such handling experiences the organism develops a large series of manipulative and constructive reactions. Here are the bases for manual skills and abilities of all sorts.

Communicative Reactions.—Human life is interpersonal and mutual. There is a commonness of experience and action which makes for an absolute homogeneity of performance. It is under such circumstances as these that infants develop expressive and communicative behavior. The obvious peak of such performances is, of course, conversational speech, but before this is possible there must develop a whole host of simple responses which make concerted action possible. Even elementary play behavior requires that directions be given to each other with respect to what must be done with things and other individuals.

In the earliest stages of language development the communicative reactions consist primarily in calling things by their names. Later on genuine reference responses are built up. Finally through a long process of concerted action children develop simple, then complex conversational responses, so that they can exchange information.

Acquisitive Responses.—The presence of property, and the various forms of its distribution as features of most families and human societies make it quite inevitable that children should take an interest in, and prize certain objects. Thus is engendered acquisitive and hoarding actions. In our own society stones, stamps, and coins become the stimulating objects for such acquisitive responses.

What particular kind of acquisitive behavior the individual performs depends upon the interests and values fostered by playmates, brothers, and sisters. In connection with such acquisitive

[4] Dell, A., Isles of Greece, Bles, 1926.

responses the individual develops rivalry, envy, and jealousy conduct of various forms.

Exhibitive Responses.—The attention and interest expended by parents upon their children invest the latter with an importance that usually results in considerable self-appreciation. This self-regard frequently induces self-display. Now begins a series of activities designed to bring oneself into the field of regard of others and even to impose oneself upon their attention. The specific behavior stock-in-trade of the exhibitive enterprises consists of performing tricks of all sorts and making clever remarks. Exhibitive behavior is very often fostered by the parents who insist upon Johnny reciting his piece before the family visitors, and may end in the cultivation of all sorts of approval and praise.

Attitudinal Responses.—In this category we put a great number of responses which mirror the effects that things and conditions have had upon the individual in his interactions with them. For example, the child builds up approval and disapproval responses. Some things he desires and approves of while others he scorns, as when the child cannot abide his tumbler of milk, in spite of parental despair. The number of likes and dislikes which the individual builds up in the basic stage of his reactional development is legion. Note, however, that those activities are not all to be regarded as preferences or the opposite. We also include in this series activities of faith and hope, the stimuli for which reside in conditions and things one would have come about, but which have not yet done so.

Accommodative Responses.—Responses which the so-called primitive peoples label taboos, and members of more complex societies, etiquette, suggest an enormous range of actions which are so engrained in individuals that it is impossible to dislodge them. Whether such actions consist of calling persons by certain kinship names, cowering before a chief, bowing oneself out of a king's presence, obeying or respecting one's parents, they represent social characteristics of the accommodative type which are ground into one's behavior equipment in the early stage of reactional development.

In every society individuals must learn to be agreeable, obey, and be pleasing to others. The social graces as well as deferential and

submissive behavior are acquired in early life. On the other hand, the child also learns to assert himself and dominate over others.

INTELLECTUAL RESPONSES.—Psychologists are rapidly revising their conception concerning children's ideas and rationalizations. It is not to be denied that their young lives teem with beliefs, opinions, and convictions, which are taken over for the most part from older persons, but which none the less represent very early developments marking children off as distinctive personalities.

The Intermingling of Responses

Throughout this attempt to catalogue the responses acquired and operating in the basic stage of reactional biography, the impression may have been developed that these are all unique and distinctive sorts of action. Such is not, however, the case. Almost any response that we have listed under the various headings may be regarded as including some of the others. Manipulative responses are not mutually exclusive with respect to intellectual reactions. Nor are the latter to be sharply sundered from protective and orientational ways of acting. Even a casual acquaintance with the actual complexity of any type of human action forces this fact to the front.

Take play reactions for instance. They not only involve combinations of exhibitive, manipulative, and creative responses, but also language, attitudinal, and other responses as well. Especially the type of play that involves identifying oneself with the heroes of stories taxes the constructive imagination of the individual.

Conditions Influencing Basic Behavior Development

Aside from the presence of certain persons and objects in the reactional milieux of the organism there are many other circumstances which determine what particular reactions it will build up. We must not only take account of the natural and cultural surroundings of the individual which make possible and necessary certain kinds of interactions, but we must also pay attention to conditions which facilitate and retard such development.

PREVIOUS DEVELOPMENT.—Since reactional biography is a record of the progressive contacts with things and of a constantly increasing acquisition of behavior equipment, each stage of this

biography must, of course, depend upon previous stages of reactional history. In every department of psychological behavior, we find that prior acquisitions constitute a necessary foundation for later ones. When one has acquired certain information, it is easier to acquire other information related to the first. Children who have already developed an interest in books take more easily to the use of them than those who have never been strongly stimulated in this direction.

Hygienic Conditions.—Hygienic conditions are also of primary importance in the basic stage of reactional biography. Anatomical and physiological deficiencies constitute an exceedingly effective handicap in the comparative development of basic conduct and equipment. Similarly, childhood disease and biological dysfunction of all varieties inevitably impair the chances of an individual coming into contact with things and developing equipment for future interactions. Good health, on the other hand, constitutes a source of energy and of numerous other advantages in one's behavior life.

Civilizational Background.—In view of our foregoing discussion it must appear inevitable that the kind of basic behavior built up by children is an index to the kind of community, nation, and race in which they grow up. It is the civilizational or cultural background which is responsible for the kind of ideas, beliefs, likes, dislikes, language, and practices that individuals acquire. In the appended reading lists the student will find materials bearing out this suggestion.

Intelligence Level of Family.—Children of intelligent parents are normally surrounded with activities, interests, and information which may be regarded as pregnant with possibilities for behavior development. Growing up in an intelligent family is conducive especially to the basic acquisition of intelligent behavior. But we may easily observe that an intelligent family is not a *sine qua non* for the development of even intelligent traits. For the children who do not grow up amidst such favorable surroundings there are numerous compensations. The street Arab whose parents and home offer little in the way of reactional advantages ferrets out such interactional opportunities for himself in the traffic of a city.

Economic Status of Family.—Economic resources condition the range of experience which the child can have. Such resources are essential for the purchase of books and pictures and for the payment of tuition in schools. Furthermore, those children who have opportunities to travel and in general to come into contact with numerous and different things find in such circumstances advantages making for a larger and richer behavior development. The writer does not at all intend to suggest the unmixed blessing of wealth as a contribution to well developed and varied personalities. It is all too well known how poverty contributes to the development of human qualities and traits which are highly admired by participants in democratic societies. But it must be admitted that such influences probably do not operate so effectively in the early basic stages of reactional history as they do in the later periods of behavior development.

Summary of the Basic Stage

Unlike the activities of the foundation stage, basic behavior does not depend very closely upon the biological organization of the individual. What does count is the range of objects of various kinds and qualities and the human conditions with which the individual progressively comes into contact. The frequency of these contacts, of course, has its bearings upon the type and amount of basic behavior development. The unbiased study of behavior acquisition in the infancy period of reactional biography is exceedingly instructive in connection with the native behavior and native capacity problem. Such a study reveals that basic reactions are humanistic phenomena and are very much influenced by the specific human circumstances of a particular individual.

CHAPTER VII

THE SOCIETAL STAGE OF REACTIONAL BIOGRAPHY

Societal Period Makes for Behavior Independence

Of all the animals the human organism sustains the most prolonged infancy. This explains why so much of the individual's personality equipment is acquired under family auspices. Finally, however, as the individual's behavior horizon broadens he enters the societal stage of development. Psychologically speaking he now leaves the narrow confines of the family circle to assume an autonomous position in his community. This means that he enters a larger field of psychological interaction. In the domain of work, whether in a factory or profession, and in social and political life, the individual discovers many more opportunities of increasing his skills, ideas, and capacities.

That which marks off the societal or adult stage from other periods of behavior history is the reactional independence of the individual. It is in this period that he acquires and performs many responses on the basis of a free interaction with things and persons aside from family tutelage.

Like all psychological phenomena, the societal period varies with individuals. With some the new behavior world lies just outside the border of family life. In such cases we do not expect any tremendous behavior expansion. With others, the range is a much wider one. The individual may go beyond his country and nation and come into contact with different civilizational surroundings such as industrial, religious, intellectual, and artistic objects, through contact with which he becomes an entirely different person than any member of his family.

How Early Does the Societal or Adult Stage Begin?

Obviously the societal period does not begin on any certain day. In fact it is impossible for us to say just when it is initiated. We

should certainly not expect any break in the behavior life of persons since they remain in contact with many of the same sorts of things as in the basic period. Furthermore, almost every person takes short steps in social adventuring long before he completely leaves the family circle. Long before the end of childhood the individual sallies forth into the larger world of social existence. We may conclude, therefore, that societal behavior development begins as an imperceptible accompaniment of the basic forms of reaction.

Generally speaking it is well to insist upon the continuity of the person's life despite its different phases. The activities begun in the basic period come to full fruition in the societal stage. Although numerous forms of behavior are developed during this period, many of them grow out of those previously acquired. Though the training of adult life is very different from that of the basic stage of behavior development it is based upon the latter. The calculus study in college is not dissevered from the algebra of high school. Nor is the latter completely dissociated from the first number lessons of infancy.

We can probably best distinguish between the basic and societal periods of development on the basis of the person's biological development. Comparatively few societal reactions parallel the biological maturation of the organism as is the case with basic responses, for we should not expect the fullest development of societal responses until the individual has reached an advanced stage of biological maturity.

Behavior Development and Reactional Performance in the Societal Period

Up to this point we have been stressing only the developmental features of reactional biography. This is quite appropriate, especially in the foundation and basic stages. But when we come to the societal period we must emphasize the nature of the performances rather than the fact of development. For this is the period of psychological maturity. The behavior equipment of persons is by this time more or less complete.

It must not be forgotten, of course, as we have pointed out, that as long as the individual lives he may continue to develop psychologically. In every case, however, it is safe to assert that there is a decided slowing down of the developmental process. Ac-

cordingly in the adult stage we may stress either the developmental or performative phases of behavior history.

Four Types of Societal Behavior

When we take account of both the developmental and performance aspects of the societal stage of reactional biography we may classify all of our activities into four distinct types of conduct. The (a) suprabasic, (b) contingential, (c) idiosyncratic, and (d) cultural reactions we may regard as illustrative of adult behavior life.

(a) Suprabasic Conduct.—Study the speech behavior of different individuals living in a large city. All speak English but with what differences! Check the linguistic reactions carefully and you find variations in vocabulary, pronunciation, grammar, voice quality, and even conversational topics. Whence came these differences? It is easily demonstrable that these speech variations represent traits carried over from an earlier period. Figuratively speaking, the individuals concerned have carried these behavior traits with them from their provincial districts to the metropolitan center.

When we examine these differing behavior traits we discover that they reveal quite definitely the behavior characteristics of the families of the different persons. Such linguistic behavior as we have indicated tell the story of the person's family origin, and the social, intellectual, and economic auspices of that family's existence.

These behavior traits we call suprabasic. As the name implies we have here adult activities originated in the basic stage which continue to operate throughout long intervals of the person's behavior life. These activities, to be sure, are considerably modified, but they bear the unmistakable stamp of having originated in an earlier stage of reactional biography. From the nature of suprabasic responses it follows that more than any other type of societal behavior they point to the definite continuity of the individual's psychological existence.

Illustrations of suprabasic behavior may be multiplied without limit. We may start with the most elementary activities, such as walking or gesturing, and run through a long list of skills and techniques, such as sewing, cooking, writing, playing, weaving, adding, and drawing. In each case we discover that the particular

way we do these acts represents performances which have a continuous history from childhood to adult life.

At this point we may venture a generalization. Many, if not most, of the activities which we ordinarily regard as characteristic of a person constitute suprabasic conduct. It is hardly possible to stop short of a person's early, basic behavior when we wish to discover the genesis of his manners, mannerisms, or wit. All these characteristics in their numerous, specific instances, may be described as elaborations of activities developed under early family circumstances.

It is probably no exaggeration to say that most of our artistic preferences and prejudices have been elaborated from elementary basic likes and dislikes. Similarly, many of our adult interests, intellectual attitudes, ideas, and superstitions are certainly derived from childhood contacts with objects and from the tales and instruction of early life.

Among the most striking of the suprabasic traits are the modes of behavior generally called intelligence. Through contact with specific sorts of situations and persons in the basic stage, the individual acquires ways of acting which in comparison with other individuals mark him as a person of a particular intelligence level. Perhaps he accepts facts without verifying them while others are far more critical in their attitudes. This general behavior status the individual maintains in modified form in his societal period of development. Similarly, most people throughout their adult life carry the impress of their early religious character. An examination of a person's belief and faith responses yields the information that they were originally initiated in the individual's basic period of development and have become more or less amplified and modified through later social contacts.

(b) Contingential Behavior.—That human life consists of one happening after another is so trite an observation as to be proverbial. Adult life is replete with emergencies and eventualities. We are constantly called upon to meet favorable and unfavorable situations, to solve problems, weather all sorts of storms, grasp opportunities, and generally obviate and resolve crises.

The behavior performed under such circumstances we call contingential. These are responses of occasion. When the person performs them he is adjusting himself to a contingency of some sort. Because contingencies are not constant or predictable, con-

tingential interactions are unique psychological events. What the individual does is conditioned by the exigencies of the situation involved. The adaptation cannot be so characteristic in form as it is in the case of suprabasic responses.

Unfortunately there are many individuals who respond to all contingencies and crises in a single characteristic manner. They become panic stricken or "hung up" and are unable to proceed with any effective performance. But this sort of situation is abnormal and belongs to a different domain of phenomena.

Contingential Interactions Based Upon Person's Total Equipment.—When I am called upon to choose whether I will accept one position or another it is clear that I cannot respond with some single response of a standard form. In this respect contingential reactions contrast with other types of behavior. In many cases psychological actions consist of the performance of certain definite equipmental responses. For example, in discrimination experiments you may well look for simple standard reactions. Thus when the subject is asked which of two lines are longer, or which of two colors are brighter, you expect the fixed responses which the individual has previously incorporated in his behavior equipment.

Generally speaking, interactions with objects are performed on the basis of particular established acts. By contrast, one cannot be equipped with a single ready-made response to meet a contingency. It is inevitable therefore that contingential interactions must be based upon one's entire behavior equipment. If the individual is to respond to the situation satisfactorily he may have to call upon all of his previously acquired behavior which has a possible bearing upon the immediate situation.

Situations are Stimuli for Contingential Behavior.—For the most part the stimulus functions for contingential behavior do not reside in objects, but in events or situations. In this fact we find another basis for their uniqueness. When interacting with objects, the individual builds up specific responses to particular stimulus functions. Hence his later contacts with these objects display a definite uniformity.

Not so, however, in the case of situations. Each type of circumstance with which the person interacts constitutes a decidedly unique event. The individual cannot, therefore, build up responses

fitting particular situations since they never happen again. When we face a genuine problematic situation, or have to make a real decision or choose some course of action, it is impossible to have ready in our equipment a particular form of response that will adapt us to the circumstances at hand.

INDIVIDUALS DIFFER IN CONTINGENTIAL BEHAVIOR.—Although the specific instances of contingential interactions are unique events we can still find variations in the way different individuals perform such behavior. For it is apparent that the total series of any individual's responses are after all characteristic of that person. It follows, then, that even contingential behavior is not without certain marks of individuality. Thus even if one cannot predict how given individuals will respond to a contingency, we still may be confident that in comparison with each other, they will differ in the way they respond to the various accidents and emergencies which they are called upon to face.

(c) IDIOSYNCRATIC BEHAVIOR.—What we admire above all in the work of a painter or composer is his originality of conception and the expertness employed in its execution. When we pass judgment on the creative action rather than on the painting or composition which is the product of such action, we use as our standard the capacity to innovate. Greatness in an artist is not the mere capacity to produce beautiful things but the ability to set the pace for a school or to invent a style. That is why Phidias, Giotto, Michelangelo, Beethoven, Wagner, and Moussorgsky are our heroes rather than their assistants or followers. The distinctive behavior of such artists comprises the high points in idiosyncratic action.

Idiosyncratic responses we may therefore characterize as the most individualistic of performances. Such activities are individualistic because the persons who perform them have built them up in their own private experience. They are grounded in a long and varied series of psychological interactions. In the field of art such unique experiences usually consist to a great extent of experiments with the conventional techniques and processes which other artists have employed.

Despite our illustrations, however, we must not make the mistake of thinking that idiosyncratic behavior is limited to artistic conduct. There are opportunities throughout the whole range of human behavior for the display of personal and original ways of

acting. It is possible for every individual to enjoy unique contacts with things and conditions which result in his building up ways of action that mark him off as a very distinct personality. When such activities are developed he has in his reactional make-up responses which he does not share with any one else.

Probably the most familiar example of idiosyncratic behavior, aside from the artistic reactions already mentioned, are the mannerisms and peculiarities of those whom we call eccentric individuals. Indeed it is conventional to speak of the behavior of such persons as idiosyncrasies. When we reflect upon the matter we find that expertness in every field of action involves the same principle of idiosyncrasy. It is such originality that characterizes the thinker whose ideas are his own, or the engineer who can think out unique solutions of a construction problem. In the expert preparation of a legal case we also observe the same striking individuality, as well as in the superior diagnosis of a physician. In every domain of behavior we find that there are individuals to whom conditions of all sorts suggest ways of action which mark them off as distinctive personalities.

(d) Cultural Behavior.—Observe the behavior of a group of persons attending a dinner party. Even though a hundred different people are present, you will notice striking similarities in the way they all interact with the various objects present and with other persons. All have come in evening dress. Uniform greetings are exchanged. Formality even governs what is eaten, while each spoon and knife must be handled exactly in a prescribed fashion. Such is cultural behavior.

Uniformity then is the essence of cultural conduct. It is such behavior which marks individuals as members of specific psychological groups. No matter how large such groups may be the actions of each person conform to distinct social patterns which are entirely typical and conventional. Insofar as individuals perform social or cultural reactions they become merged with others in the formation of a particular group. Thus in contradistinction to idiosyncratic behavior which makes individuals stand out as distinctive personalities, cultural conduct stamps a person as a mere unit in a series. As members of social psychological groups, individuals share with each other the specific reactions which constitute the thoughts, manners, languages, beliefs, and ideas of such groups.

SPECIAL CHARACTERISTICS OF CULTURAL BEHAVIOR.—What difference does it make how one eats one's salad? And yet the members of particular groups meticulously avoid cutting their lettuce with a knife. This fact sympolizes the *artificiality* of cultural behavior. In general, cultural responses are far removed from the natural conditions or properties of things. What we eat and the way we eat it bears no definite relationship to the nutritive value of food. We dress with little or no regard for climatic conditions. Not infrequently the artificial character of conventional or cultural responses leads to very harmful effects.

Another characteristic of cultural reactions is their *arbitrariness.* Persons paint, tattoo, and scarify their faces to make themselves beautiful. In all such socially demanded action there is really no standard of beauty consulted. No better illustration of such arbitrariness of cultural behavior is the way we name things. Compare the act of a scientist who names a thing on the basis of one of its prominent characteristics and the ordinary way of merely applying a term to an object. Here we recall the familiar joke about the English country-woman, who, when she first discovered that the French call a knife "couteau," remarked that the French are funny people for calling a knife by such a name, for it could not be denied that it was after all a "knife."

When we study the judgments of persons concerning things, make note of the kind of actions of which they approve or disapprove, or examine what they believe about God, we find that for the most part such actions are social in character and are *imposed* upon the persons concerned. This means that they have not acquired such reactions as the result of their free personal contacts with things. Rather, by virtue of their inevitable presence in particular human groups they have taken on such modes of behavior. We become Buddhists or Christians, Catholics or Protestants, Germans or Frenchmen by being born and living under such cultural auspices.

But once we have become culturalized in a certain way we become *dominated* by that form of action. The prejudices, beliefs, superstitions, and manners that we acquire by this method interfere with our further development in those directions. To be thoroughly culturalized in a particular way means that we will not be able to appreciate other ways of acting. To a republican the very thought of monarchy is revolting, and just in the measure that the repub-

lican's prejudices are ingrained he can not see the merits or even the possibilities of monarchy.

It is characteristic, too, of our cultural reactions that they are *unwittingly* acquired. We seem to absorb them from the various persons who belong to our social psychological groups. Accordingly, we are sometimes surprised when we discover how we do act. This occurs, of course, only when we have occasion to compare our own cultural responses with those of other people. It is sometimes shocking to find that others do not have the same manners, customs, speech, ideas, and prejudices that we have. Especially is this the case when we find that some of our most cherished ideals are only prejudices, and our valued ideas only superstitions.

And finally, cultural reactions usually constitute *permanent* traits. When individuals develop conventional behavior in particular social situations they generally retain such conduct throughout their lives. When, however, such individuals move out of the social system in which they were born they may adopt the behavior of other groups. Immigrants become reculturalized and adopt the language, beliefs, customs, and manners of the new community in which they settle.

Most Responses are Cultural.—It is safe to say that most of our behavior is cultural. How few of us ever think independently or develop judgments based upon our own personal contacts with things. Ordinarily we believe exactly as other members of our psychological communities do. Free thinking is a rarity. Freedom of thought, in the ordinary sense of the word, merely means that we are not prevented by some particular group from thinking the way some other group does. It is still a matter then of convention or group thinking rather than individual thinking. If our intellectual conduct, which has the largest chance of being nonsocial in character, turns out to be cultural, it is easy to conclude that our manners, speech, and other more overt reactions are completely conventional and shared.

Two Ways of Developing Cultural Reactions.—Like other types of action, cultural responses are developed through the casual contacts of individuals with particular kinds of objects and situations. But as it happens, cultural behavior represents activities which fit individuals into particular behavior groups. The group therefore demands that all members shall conform in their reac-

tions to the other members. It therefore deliberately induces individuals to develop certain responses.

Accordingly, societies have evolved various techniques and instruments leading to the homogeneity of behavior on the part of all the units in a group. Among these may be mentioned the ceremonials connected with religious practices and political attitudes. The ceremonials of confirmation have a tremendous influence upon religious attitudes and worship. Flag days and May days serve very effectively to bring about common responses in political and economic organizations.

There is no more potent instrument of culturalization in complex societies than the schools. School life operates to level out differences in persons with respect to knowledge and ideals, as well as ordinary social deportment. Schools serve invariably to make individuals acquire the same forms of behavior as the other participants and in consequence induce an unmistakable psychological similarity in all the persons concerned. It is in this way that the schools serve to make the younger members of a community increasingly like the older ones.

Probably the most effective instrument of mature culturalization is the newspaper. Through various processes of news control and advertising in its various forms, individuals are influenced to acquire opinions, beliefs, and all kinds of practices which they share with others. Social mentality is not only developed originally by propaganda but it is also modified and transformed by the same means.

What is commonly referred to as public opinion is a less tangible instrument working to induce the development of social reactions. By honoring those who conform and ostracising those who do not, public opinion becomes a definite agency in psychological development. When public opinion is most effective it operates of course in conjunction with the schools and newspapers to induce the acquisition and performance of conventionally acceptable behavior.

Stimuli for Cultural Reactions.—When I meet a woman on the street I am stimulated to tip my hat. This means that in my social group women are endowed with the property of calling out such behavior. In other human groups they have not had such properties attributed to them. But on the other hand, there

are groups in which men as well as women have acquired such stimulational properties, for there men tip their hats to both men and women alike. These properties of persons or things to call out such distinctive cultural responses are cultural or institutional stimuli. Institutional stimulus functions therefore may have nothing to do with the natural properties of things. In this respect cultural stimuli differ decidedly from other types and especially reflex stimuli. An object's cultural properties exist only because they have been established by a certain group.

Summary of the Societal Stage

Societal behavior consists primarily of the actions belonging to the adult stage of reactional biography. These responses are acquired after the individual has reached a fairly mature biological level and are called forth by the particular personal and social conditions found in the adult stage of one's behavior history.

Among the four distinctive types of societal reactions we have first, the *suprabasic* responses which are definitely developed upon a previous behavior basis. These are modified forms of responses originally developed in the basic stage of reactional development.

A second type of societal behavior stresses the conditions under which the reactions are performed. *Contingential* responses are not performed on the basis of specific elements of reactional equipment but involve large numbers of equipmental responses. These are performed when we react to unique and indeterminate situations.

The *idiosyncratic* forms of societal behavior are responses which are the unique performances of certain individuals. They are built up in the particular behavior history of persons.

The fourth type of societal behavior consists of the *cultural* responses, which are standard forms of performance developed by numbers of individuals belonging to specific social psychological groups.

CHAPTER VIII

PSYCHOLOGICAL PERSONALITY

Personality the Unit of Psychological Organization

Our study so far has been concerned with the description of psychological events as discrete phenomena. We have studied isolated interactions of responses and stimuli, and the way these phenomena are developed. It is obvious, however, that this is only part of the psychological story. My responses to stimuli are not isolated events. They are always characteristic of me as a psychological organism. This means that practically every act that I perform is conditioned by my other actions. There is a definite organizational principle in my behavior. Psychological phenomena always involve a unity. The investigation of this integrational aspect of our behavior constitutes the problem of personality.

Two Bases for Personality Organization

There are two general conditions that make for the unification of psychological events and for the organization of reactions into a personality system.

Biological Unity of Individual.—In the first place, there is the biological unity of the person. Every biological organism is a unique organization of structures and functions, and no matter how dependent upon other organisms for its existence it is always distinctly individual. All of the behavior of any particular organism must, of course, be centered in this organism.

Unique Reactional Biography.—In the second place, there is the reactional biography. This, it is apparent, constitutes a unified series of behavior experiences. On the whole the opportunities and occasions for behavior are of a piece. The natural environment, the social and economic surroundings of a person constitute a homogeneous setting for his behavior. We see therefore that

the facts of reactional biography make for the interrelation and integration of every person's conduct.

Why We Must Study Personality

We have already suggested that personality study is necessary since all psychological reactions are the acts of particular individuals. But this is not the only reason. To begin with, we constantly face the problem of behavior prediction. What are the probabilities that X will do so and so, under certain given conditions? Only if we know the make-up of an individual's personality equipment can we plan ahead with respect to him. Will the soldier flinch under fire? Will the physician be able to diagnose the disease? Will the employee faithfully and industriously carry out instructions? These are important questions that only a knowledge of personality can help us to answer.

Again, in dealing with individuals it is often necessary to know what their intentions are. Such knowledge is required not only to anticipate responses, but also to be able to judge a person's conduct. The judge and jury are able to decide whether an individual is liable to punishment if they know what the individual's plans were in a given situation.

When colleges are overcrowded the authorities must decide who should be preferred for admittance. This is essentially a problem of comparing individuals. If we are to take account of the likenesses and differences between persons we must have some information concerning them as integrated personalities. In a practical way, of course, we ascertain the qualities of personalities through tests of some sort.

Once the student is admitted to college it is necessary to measure his progress. Here again we face a personality problem. Assuming that we can discover the nature of the individual's behavior equipment we thereby achieve a basis for judging the rate at which the individual accumulates skills, capacities, and information.

Personality as Psychological Structure

Through the conception of personality we are enabled to treat psychological responses not merely as momentary events but as phenomena which endure long enough to be compared, contrasted, and criticized. The problem of personality therefore involves the study of the durational aspect of psychological phenomena.

Personality, then, as the organized and stable fact of fleeting events may be regarded as the structural aspect of psychological life. But as structure, personality must be studied in the spirit of modern science, namely as a descriptive tool. We must not forget that personality is after all the name for the complement of a given individual's momentary response events.

Personality Frequently Misinterpreted

Despite the fact that the conception of personality is one of the most important in the whole field of psychology there is none that is more frequently misinterpreted. The reason for this, perhaps, is that the word personality is used both in a popular and a technical sense. What sort of fact does the term personality stand for?

When employed in a popular sense, the word personality usually means nothing in particular. When it does mean something definite, it frequently refers to superior qualities. Sometimes we mean by personality an attractive appearance based on certain anatomical traits such as tallness, slenderness, fine complexion, and color. In other cases, personality stands for good grooming. To possess a fine personality in this instance means to wear neat, well fitting, or beautiful clothes. But no doubt we find the greatest difficulty in saying what personality means when we think the term represents such intangible qualities as magnetism and charm.

Popular conceptions of personality are clearly far removed from the psychological domain. Sometimes, however, the everyday conception comes very close to psychological facts. This is the case when the term refers to certain desirable or valuable action traits. For instance, when personality means trustworthiness, honorable behavior, pleasingness of speech or carriage, it approaches the standing of a psychological term. Even the idea of the magnetic personality may be psychological when we regard magnetism as speaking convincingly or in general as acting in a way to inspire confidence. We may conclude then that personality as a psychological phenomenon must invariably mean responses whether desirable or undesirable, since there are desirable as well as undesirable personalities.

Psychological Personality Consists of Behavior

A clear cut distinction can be made between the psychological and popular use of the term personality by observing that from a

psychological standpoint personality always refers to conduct. Psychological personality means ways in which the individual interacts with things. Whenever personality represents "talking convincingly" or "acting graciously" as over against the qualities of height or complexion, the term belongs within the boundaries of psychology. What may be lacking then is merely the completeness and definiteness of reference which a scientific term demands.

Psychological Personality Defined

Personality may be defined as the totality of a particular individual's reactions, in sum, everything the individual does and can do. This series of reaction systems we may refer to as the behavior equipment of the individual. Every psychological personality comprises a tremendously large number of reaction systems which in various interactional combinations constitute the individual's information, skill, abilities, and capacities.

Personality a Product of Reactional Biography

Whence do we derive the totality of our equipment? We have already discovered the answer in the study of our psychological development. Personality is a product of reactional biography. It is impossible for us to have overlooked the fact that in passing through the various stages of his biography the person acquires a series of reaction systems. Through his interactions with things the individual acquires characteristic ways of acting, that is to say, a series of more or less permanent behavior characteristics or traits. This behavior history in the case of each individual results in a particular psychological personality.

No Two Personalities Alike

Every student of psychology must be struck by the outstanding differences in persons. We are simply amazed by the utter superiorities of certain persons and the unmitigated inferiorities of others in certain respects. Setting aside the abnormal and pathological personalities, probably the most notable superiorities are those which have been labeled genius. Here is a man who excels in musical composition and there is one who cannot be approached in the matter of political judgment. Such superiorities are manifest. There are geniuses of all sorts. We find them in the fields

of mechanical invention, military leadership, industrial organization, and salesmanship.

The term genius therefore stands for reactional superiority. It does not imply any mysterious power. For all knowledge, skills, knacks, proficiencies, capacities, and abilities are specific forms of interactions with particular objects. The name genius belongs to the family which includes virtuoso, expert, connoisseur, mastermind, each of which stands for great proficiency and even supremacy in knowledge, talent, technique, constructiveness, bodily strength, or even "physical" endurance.

Whether we deal with the superiorities or inferiorities of persons in capacity, work, or achievement, we are merely studying their extreme variations along these different lines. In all these cases we have arresting illustrations of the fundamental psychological law that all persons are individually different. Each person has his own unique equipment of knowledge and skill reactions. Examine any two persons and you find them different in their behavior equipment. A may know a great deal about astronomy, while B knows nothing at all. But on the other hand, B may know a lot about electricity, while A is ignorant in this field. C can paint pictures or design buildings, while D can cook and bake instead. Or D may be able to cook and bake in addition to the capacities of C. Notice too that E and F may both understand agriculture or invent machines, but they differ in the degree of their skill.

This inevitable variation of personalities is not difficult to comprehend when we realize that every normal individual has in his personality equipment millions of different specific reaction systems. The particular combination of these traits differs with each individual, thus giving him his own unique personality equipment.

How can we account for these individual differences? Since personality is a product of reactional history we must look there for our answer. If we have observed carefully the nature and operation of reactional biography, we know that it cannot be the same for any two individuals. Accordingly every person is different in some respects from every other. These differences may be as great as that between a genius and an ordinary mortal, or they may amount merely to the fact that one person performs more idiosyncratic reactions than another or belongs to different social groups, so that he has acquired different cultural behavior.

To account for individual differences, therefore, it is necessary to examine the specific conditions surrounding the development of persons. We must consider the kinds of objects, peoples, and circumstances which constitute the things with which they interact. These circumstances include the intricate organization of natural, ethical, social, economic, and artistic factors to which all individuals must adapt themselves. Contact with one set of these conditioning factors results in one type of personality, the interaction with another set means the development of quite a different type. It is true therefore that in precisely the degree that persons pass through similar behavior histories they resemble each other as personalities.

Catalogue of Personality Equipment

Inscribed upon the temple of Delphi was the famous inscription "Know Thyself." Today students of psychology can appreciate this challenge more vividly than ever before. We can translate it to mean a thorough cataloguing of the various responses that go to make up the behavior equipment of one's own personality. These activities when regarded as pertaining to a given person we call personality traits.

But how can this be done? We know that the responses comprised in any behavior equipment run into millions. The only way out appears to be the organization of responses into classes.

ABILITIES.[1]—Popular speech has distinguished between thought and action. The personality traits called abilities consist of all types of responses which come under the latter term. Standing, walking, singing, cooking, dancing, speaking, drawing, sculpturing, building, and sketching, in sum, all sorts of adjustmental, verbal, and manipulative actions, are classified as abilities. Everybody has a large complement of such traits, though not the same ones or the same combination of them.

SKILLS.—Are you skilful at some work or game? To answer this question satisfactorily you must not merely affirm that you can set type or play chess. Rather, you must tell how well you can do the action in question. Skill can therefore be defined as a way of doing something expertly upon the basis of a given standard.

[1] At the outset the student must be cautioned that these terms do not have standard meanings for psychologists, and that the following traits are not all mutually exclusive. Such a catalogue is only an attempt to divide off from each other different kinds of performances.

The standard may be to excel in a performance by comparison with some other person or a number of performers, or it may be some accepted degree of perfection.

Skill can be measured in terms of amount of production. In a factory you are regarded as skilled when you can make so many acceptable products in a given time. In a game, or in some art as music or sculpture, the criterion of excellence is mostly employed. Thus we use such descriptive terms as maestro and virtuoso to designate skilful individuals.

CAPACITIES AND APTITUDES.—Psychologists frequently use these terms as synonymous with the word traits. That is to say, they mean by capacities and traits any action that a person is expected to perform when a certain stimulus is presented, even though he is at the moment not engaged in that particular interaction. Sometimes, writers go so far as to assert that capacities are innate traits of action that are not developed or acquired, but merely manifest themselves.

It is our conviction, however, that these terms best describe process reactions. We have capacities or aptitudes for adding because when we learn arithmetic we acquire a process response; so that we not only can add the particular numbers we work with but any numbers that fit into that process. There are many situations in every trade and profession in which we acquire the capacity or aptitude to recombine given elements. Automobile driving illustrates the process form of response. When you have learned to drive a particular make of car you have acquired the aptitude or capacity to drive any make regardless of differences between them.

ACCOMPLISHMENTS.—Not many decades ago the ideas of the upper class population were such that men and women were required to have different personality traits. For present purposes we need only indicate that knowledge and industrial techniques were not so much demanded of women as accomplishments. The latter may be simply described as socially approved and admired performances. The emphasis upon accomplishments for women was reflected in the goal set for their education which was "to render them correct in their manners, respectable in their families, and agreeable in society."

Now that a process of sex equalization is in vogue women are not segregated into a class of persons who merely read poetry,

dance, perform on some musical instrument, and cultivate pretty speech, while their brothers acquire the traits pertaining to the more serious business of life.

Another way to describe accomplishments is to say that they are traits placing individuals in a class above others. In some instances such responses are merely highly proficient forms of acts everyone can perform. In others they are forms of behavior that few are willing or able to acquire, for instance the ability to speak one or more foreign languages.

HABITS.—From the statistics of cigarette and cigar production in America one might infer that nobody escapes the smoking habit. At any rate it is clear what the term habit as a personality trait stands for.[2] In formal language a habit is a characteristic form of constant behavior. Not infrequently do such habits bear the imprint of a particular society. Thus gum and betel nut chewing are local traits. Other illustrations of habits are truth telling, bead counting, and hat tipping.

DISPOSITION AND TEMPERAMENT.—These are the feeling traits which contrast with the doing equipment. Consider first the affective coloring of responses. Some things we do in a "happy frame of mind," while some acts we perform "unhappily" or even "unfeelingly." The second type of feeling equipment consists of more or less permanent moods or dispositions. Thus some persons are chronically optimistic or pessimistic. Then, too, there are those striking dispositions commonly illustrated by the periodic display of the theatrical star which interferes with her dependability as a public performer. These are popularly spoken of as temperament.

MANNERS AND MANNERISMS.—The incisive question what manner of man one is, has a specialized meaning in the discussion of personality traits. It is often an individual's manners that give color and complexion to his personality. X is shy, suave, and withdrawn, whereas Y is bold, crude, and aggressive, while Z on the other hand, may be suave but at the same time aggressive. It is plain that the activities prescribed by the etiquette books are only particular kinds of manner traits.

Exaggerated manner traits may be called mannerisms. Most of us possess a number of such mannerisms of speech, dress, or

[2] Habits in this sense include actions that from a strictly psychological standpoint must be otherwise defined. See Chap. 16, pp. 247 ff.

carriage. When such traits are deliberately acquired we apply to them the disapproving term of affectations.

Ideals, Ambitions, and Aspirations.—"To peruse by items the catalogue of any man's endowments" is to discover a series of ambitions, ideals, and aspirations. The period of youth, before "the slings and arrows of outrageous fortune" have shot away the armor of illusion, is especially the period of ideals. However, they are never absent. Ideals we define as reactions of constructing, accepting, and maintaining conceptions of what ought to be both in conduct and in the nature of things.

Ideals may be practical or non-practical. Our ideals of honesty and fair-play may work out in concrete behavior. By contrast the ideal of universal and permanent peace, or the absolutely just distribution of economic goods may be too remote from our own endeavors to have much influence upon our conduct.

Even those human beings occupying very humble stations in life distinguish themselves by possessing particular sorts of ambitions and aspirations. Whether one is stimulated by one's own lowly position or by some other person's social, economic, or intellectual eminence, there is hardly any escape from a desire to modify one's personal circumstances. Even Diogenes, who was content to live in a tub, was ambitious to be the first discoverer of an honest man.

Naturally ambitions and desires are of all sorts. Those who wish to achieve a superior position in the community aspire to be well thought of. There are those who renounce wealth, but on the other hand are ambitious to make a great scientific discovery.

Our ambitions and aspirations can be classified on the basis of whether or not they are connected with achieving responses. We may aspire to some higher mode of living, but do nothing further about it; on the other hand, we may strain every fibre of our being to materialize our aspirations.

Tastes.—The most elementary form of taste reaction undoubtedly is merely likes and dislikes. Our more complex tastes are responses of appreciation with respect to certain objects, persons, and situations. Although appreciations differ greatly, we still find that every personality is equipped with such responses. Some have few musical or other artistic tastes but they may appreciate craftsmanship in machines or other non-aesthetic objects.

How tastes are evaluated depends upon various social and individual standards. From the social standpoint good and bad tastes are usually a matter of conformity. Aside from the social criterion of conformity, tastes may be judged on the basis of the qualities of things to which they are responses. Those who possess superior taste prefer good to bad poetry.

Talents.—Talents bear the same relation to capacities as skills do to abilities. Talents represent excellencies in the performance of process reactions. For this reason we usually think of talents more in connection with inventive and creative conduct. In fact, in popular thought talents are exclusively related to the creative processes of art. Persons are spoken of as having talent for music or painting. There is good reason, however, for extending the term to cover expertness and superior aptitudes in the performance of all sorts of process responses. One may display talents in salesmanship, in conversation, in watchmaking, in apparatus making, as well as in the arts. The psychological basis of talents is a concentration upon a certain phase of interaction with particular things (practicing music or solving mathematical problems, for example); so that one behaves energetically with respect to these things (musical objects and processes) and can bring to bear upon any present behavior situation the results of many similar experiences.

Attitudes.—No personality is without its complement of intellectual attitudes. An attitude may be defined as an intellectual position taken with respect to things, persons, and conditions. Among the simpler attitudes are assumptions concerning the existence or non-existence of certain things (republican or democratic perfidy), or the propriety and value of certain movements (abolition of slavery or taxes), and laws (prohibition). In more positive form one's attitudes constitute opinions and beliefs, some of which are named from the kinds of things toward which they constitute responses. Here we may cite pacifistic or non pacifistic attitudes. In other cases the attitudes serve to characterize a person as tolerant or intolerant, dogmatic or fair-minded. Superstitions of all sorts are attitudes that everybody has, but that most people deny and disapprove of.

Fears and Phobias.—If it be true that no man is stronger in his resolutions than his fears allow, then it is plain that fears are practically the backbone of his personality. But whether this is

true or not, certain it is that fears constitute prominent features of our personality make-up. They range from mere timidities in the presence of particular persons, animals, or situations, to those intense phobias that have serious influences upon the individual's life. The morbid fears and compulsions of psychiatric literature are examples of the latter. Between these two fall various shrinkings from objects and conditions which only slightly tinge the complexion of the personality equipment in which they are included.

KNOWLEDGE.—We complete our survey of personality traits with the reactions which go under the names of knowledge, ideas, and information. It is unnecessary to say that such activities constitute a large portion of every personality equipment, although they differ greatly in quality, quantity, and in the objects to which they are reactions. Merely to mention these types of traits is to suggest that they are the bases for all sorts of inventions and originality in psychological adaptation.

Personality Types

ABSOLUTE TYPES.—The extreme complexity of every personality and the enormous variations between different personalities have always appeared as a distinct challenge to students. Innumerable attempts have therefore been made to separate personalities into types. For the most part in the history of psychology, types have been regarded as absolute. In other words, personality has not been considered as actual equipment of specific responses acquired in a definite reactional biography.

A characteristic sample of such an ultimate conception of types is that which has come down to us in the modified doctrine of Galen, a Greek physician of the second century. According to this conception there are four fundamental types of temperaments—namely, the sanguine, melancholic, choleric, and phlegmatic. These types are presumed to be based upon predominance of one of the four fluids in the body. In sanguine individuals, the blood predominates; in the melancholic, black bile; in the choleric, choler or yellow bile; and in the phlegmatic, phlegm. In behavior, the sanguine are warm hearted and quick acting, the choleric vigorous and impulsive, the melancholic depressed, and the phlegmatic slow and calculating.

In more recent times the viewpoint has become popular that all persons can be divided into two great types, the introverts, and the

extroverts. The former are individuals whose actions are mainly reflected into themselves, whereas the extroverts are persons whose behavior is directed toward the outer world. The introvert is the thinker; the extrovert, the man of action or feeling.

Jung, the Swiss psychiatrist who is responsible for this theory, has modified it considerably. His latest formulation is that both the introvert and extrovert personalities can be divided into four types; the thinking type he describes as those exclusively influenced by what they think; the sensation type he calls the person who is satisfied with the way things appear on the surface; the feeling type includes individuals who are in all things guided by their feelings; while the intuitive type is the seeker after possibilities, the speculator. Members of each type incline either toward external objects or the inner self. Thus there are at least eight distinct types.

PRACTICAL TYPES.—No serious suggestion of personality types can fail to serve as a practical classification of individuals. Especially is this true when the types describe some way of responding or acting. But on the other hand, all enterprises of dividing persons into ultimate types immediately become bankrupt in the face of concrete facts. No one can possibly act in a fixed way under every circumstance. Granted that introversion and extroversion actually represent ways of action, these terms only characterize the behavior of certain individuals under specific circumstances. In other situations the introvert becomes an extrovert and vice-versa. In the last analysis personalities are unique and are individually different. Human beings are individuals and not types.

Personality types are only pragmatic classes. Since personality consists only of concrete psychological responses, types serve merely to emphasize the fact that persons frequently incline toward certain forms of behavior under particular situations and time periods.

The *reflective* person is easily distinguished from the *impulsively* acting individual. The former analyzes his motives and aims. He wants to be intellectually oriented in any situation before he acts. The latter plunges into action with very little prior consideration. The terms introvert and extrovert are quite fitting to distinguish these individuals.

In some persons *artistic* and *aesthetic* behavior is very prominent. The aesthetic individual aims to avoid all acts and things

that are contaminated by the motives of use and achievement. Rather he attempts to govern his life and surroundings by ideals of beauty. He abhors nothing more than the philistine and his works.

Professor James has offered a suggestive contrast between personalities in the philosophical world. He places the *tender-minded* person who is spiritually inclined, sharply over against the *tough-minded* thinker, who must deal with realities and even materialities. The English poet Blake declared that men could be divided into two classes, the *prolific* and the *devouring*. The former produce; the latter absorb from others like a sponge. Among mathematicians there are, says Poincaré, two types, the *logical* and the *intuitive*. The logical mathematician is primarily interested in systematic construction, while the intuitive thinker is sensitive to the actual world. Ostwald, a German chemist, divides scientists into the *classicists* who may do little work but that must be done with exquisite perfection, and the *romantics* who are original and prolific though they do not perfect their work.

We are all familiar with the *vagabond* types, those free and unrestrained personalities who live their lives as far as possible without regard to the prescriptions or limitations of society. Again there is the *drifter* or rolling stone who despises position or possessions. These types of personality we may place in contrast with both the *miser* whose ruling passion is worldly goods and more worldly goods, and the *goal pursuer* who permits some definite objective to lead him on through all sorts of devious paths.

Even these few examples of personality types suggest what an endless task it would be to list all the possible personality patterns. We conclude by suggesting only a few more contrasting types such as the dependable-undependable, conservative-radical, domineering-submissive, articulate-inarticulate, and the bold-withdrawn individuals.

Abnormalities of Personality

It would be surprising indeed if among the countless traits comprised within a personality equipment there were not some that are odd or peculiar. This means that we ought to expect every person to build up some behavior traits that set him off from other individuals. Any foreigner settled in a strange community displays such divergencies of personality. When these behavior traits are

sufficiently exaggerated to attract notice or to unfit the person for living in the society in which he finds himself, they are labeled abnormal.

Lack of Behavior Development.—From the standpoint of reactional biography or the development of personality we may indicate two great sources of abnormality. Many personalities are defective because they have been unable to build up necessary behavior equipment as have other members of the same community. These individuals, lacking the requisite responses, are not able to adapt themselves to the same general social and economic conditions. Possibly the abnormalities in certain cases are due to some biological condition, the loss of some anatomical organ for instance. Other fundamental defects are not directly due to biological circumstances, but can be traced to a lack of opportunity to come into contact with certain things and situations. Personalities of this type are defective by deprivation.

Wrong Behavior Development.—The other source of defective personality is the acquisition of behavior unfitting the individual to meet the exigencies of his natural, social, and economic surroundings. Delinquents are persons who build up habits of action, ideas of right and wrong which make them unable to get on with other people who entertain different conceptions of propriety and personal rights. The repressed individual acquires reactions of withdrawal from the society of others. Becoming shut in, exclusive, and unresponsive to persons and circumstances, he may develop into a melancholic, or grow into a stuporous condition. On the other hand, the individual who develops unrestrained responses may become an expressive and excitable personality. Such persons respond with the frankness of children, leaving themselves no private thoughts or actions, and thus are excluded from normal contact with their fellows.

These are only hints at the great number of exaggerated or defective personalities. The legion of pathological personalities comprise in addition the manics, the neurasthenics, the multiple personalities, etc.

Personality and Anatomical Type

From the very dawn of psychology students of the human mind have attempted to find a correlation between type of personality and

the biological (anatomical and physiological) character of the organism. In some form or other the shape, size, and physiological functioning of the organism have been regarded as indices of a person's psychological traits. Shakespeare expresses through Cæsar the essence of this view.

> Let me have men about me that are fat,
> Sleek-headed men, and such as sleep o'nights.
> Yond' Cassius has a lean and hungry look;
> He thinks too much; such men are dangerous.

One of the most prominent developments of the attitude under discussion is that of Lombroso, the famous Italian criminologist who devoted his life to the investigation of the biological abnormalities which he believed to be the basis of criminality. He isolated such factors as malformations of the skull, brain, and face. He also thought that criminal traits were correlated with abnormalities of the sense organs, mouth, teeth, or tongue.

Within the present decade Nacarrati, a disciple of Viola, Pende, and others of the modern Italian school of body constitutionalists, has attempted to find correlations between various body ratios, and personality or phases of personality. Among these correlations is the connecting of the ratio of the lengths of the limbs to the volume of the trunk, called morphologic index, with (1) psychoneuroses, (2) temperamental disturbances and (3) general intelligence.

Kretschmer, a German psychiatrist, divides people into three principal biological types, (1) the asthenic individuals of slight build, (2) athletic or muscular, and (3) pyknic or stoutish individuals. Furthermore, he declares that there is a clear biological affinity between the pyknic type and the manic-depressive form of insanity, while the schizophrenic form of mental pathology is biologically related to the asthenic and athletic types. He believes also that there are biological affinities between the scientist who searches for facts and the pyknic type, while the athletic and asthenic physiques correlate with abstract thinking personalities.

A very interesting enterprise in the direction of correlating biological and psychological characteristics is to search for a relationship between personality traits and the functioning of the endocrine glands. The claim is made that the traits which made Cæsar and Napoleon what they were can be accounted for by the way their pituitary, adrenal, and other glands operated.

Who can deny that anatomical and physiological type plays a part in the development of personality traits? If it is true that an organism is a unitary organization of all of its organs and functions we need not hesitate to accept the conception that its anatomical character has some influence upon the way it reacts.

But how is this influence conceived? Surely not as an inevitable cause of certain traits. Nor can we think of particular traits as correlated with particular forms of anatomical or physiological conditions. We must look upon the anatomical construction as a condition in the development and operation of responses. Indeed, sometimes these anatomical conditions merely operate as stimuli for other persons to react to an individual in a way which leads him to develop certain traits. The red-headed boy taunted by his playmates may become either a cowed, withdrawn person, or an especially pugnacious individual.

Nothing is easier than to find instances illustrating that fat people are jolly, while thin persons are sombre. An otherwise very profound student of labor problems thought he discovered the rule that the thick-necked labor leader was less conservative than the thin-necked one. But we cannot be misled by such superficial correlations to assume that there is anything but an accidental connection here, or that there are no other kinds of correlations. Who does not know jolly persons who are thin or stout individuals who are staid and even melancholic?

Nor can we escape the observation that the whole problem of biological types is based upon surface observation. There is no warrant for thinking of types as absolute characters. On the contrary we must consider each person's physique and chemique as a result of a combination of empirical circumstances. Think only of the differences between the peasant women of Europe and their upper class sisters. Are these differences predictable on any other basis than the lives they have been brought up to lead?

On the whole, too, it must be suggested that those who seek to correlate biological with psychological types make the same assumption about absolute types on the psychological side. In this sense there is a strong probability that the correlational errors are immediately multiplied by two. Granting that an individual may be casually labeled as a manic depressive or a schizoid, this does not mean that he is not the other type also. At best then one finds only a surface relation, but the question always remains whether one

should correlate the biological tendency toward body form with one or the other psychological characteristic.

And finally we cannot urge too strongly that in all studies of relationship between biological make-up and personality traits we must not lose sight of the fact that, after all, psychological phenomena are results of the interaction of the individual with objects and persons. If we think of a person's traits as the inevitable results of certain biological circumstances we overlook fundamental scientific principles.

The Investigation of Particular Personalities

Generally speaking psychologists have devised three lines of investigation in the study of personality.

A. Personality Analysis.—The first of these investigative procedures consists of an attempt to analyze the total set of traits of a particular individual, or at least enough to assure an acquaintance with the individual being studied.

This line of investigation consists essentially in the formulation of an inventory or data sheet. Upon this sheet are printed such questions as the following:

> Can you easily control your temper?
> Do you get along well with people?
> Are your feelings easily hurt?
> Do you easily take part in conversation?
> How do you feel when praised?

In some of the questionnaires the questions are to be answered either, "yes," or "no"; in others the reply may be, "always," "sometimes," or "never."

Because such personality analyses were originally prompted by an interest in unadjusted or pathological personalities many of these schedules have been organized to discover undesirable traits. But in general the aim is to analyze and characterize a personality taken as a whole.

The student who wishes to inform himself concerning these investigations of personality, commonly called the pencil and paper method, is referred to the following typical data sheets: Wood-

worth, Personal Data Sheet;[3] Laird, Personal Inventory;[4] and Thurstone, Personality Schedule.[5]

B. Discovery of Traits.—The second type of personality investigation is designed to discover whether certain kinds of traits exist in the equipment of particular individuals. As it happens, the traits looked for mostly have been those described as social, emotional, or moral. The particular methods of investigation vary considerably. May and Hartshorne refer to a hundred kinds of tests that have been standardized or proposed.[6]

Situation Tests.—In a number of studies individuals have been presented with situations in order to see how they would react. Typical situations of this sort are sending a child to a storekeeper with whom it is arranged to give back more change than the purchaser is entitled to, to see if he will return it; giving a child a chance to cheat in school work, or to take a tip as a violation of a boy scout regulation. May and Hartshorne have investigated among other traits those of aggressiveness, honesty, reliability, conscientiousness, truthfulness, fairmindedness, etc.

Rating Methods.—Various investigators have attempted to discover traits in individuals by having them rate themselves for action traits or rated by other individuals. Sometimes the former are compared with the latter. The specific rating procedures vary also. In some cases the raters are simply asked to say whether X possesses such and such traits, and in other instances he is compared with other individuals or with an imaginary person.

Interview Method.—Here the individual is simply questioned by the investigator and upon the basis of "leading questions" the investigator satisfies himself that an individual possesses certain traits. This, of course, is an elaboration of the ordinary process of an employer interviewing a candidate for a position.

Questionnaire Method.—This is the same method as that in which the data sheet is employed in general personality analysis, except that the interest here is in certain traits for specific purposes. The present method is designed to elicit information concerning

3 Printed in Franz, Handbook of Mental Examination Methods, (2), 1919.

4 Published by Hamilton Republican, Hamilton, N. Y., 1924.

5 Univ. of Chicago Press, 1929.

6 Objective methods of measuring character, *J. Genet. Psych.*, 1925, 32, 45-67.

the traits of the individual in order to discover the probabilities of action on the part of an employee of a bank, for example.

Cross-Out Test.—In the well known x-o test of Pressey the aim is to discover the emotionality of an individual. The procedure is to have the subject cross out words from lists which he regards as unpleasant or immoral, or about which he is worried. The assumption is that in this way will be revealed the characteristic emotional traits of the subject.

Downey Will-Temperament Test.—A method of personality investigation which has attracted considerable interest was devised to discover the "will and temperament traits." The procedure consists essentially of having persons write phrases under various conditions. For instance, an obstacle is placed in the way of the writer to test one's resistance to opposition.

Annoyance Test.—Cason has recently formulated a series of 214 annoying things and situations. These are printed on a sheet as follows:

( ) 1. A person behaving in an affected manner.
( ) 2. A person with a gushing manner.
( ) 3. A person losing his temper.

The person to be tested puts an evaluating symbol in the parentheses according to this scale.

3—Extremely annoying.
2—Moderately annoying.
1—Slightly annoying.
0—Not annoying.
x—Have not been in the situation.

It is assumed that the results of the test will reveal information concerning the affective character of the person tested.

Aptitude Test.—Some of the most definite personality investigations are the attempts to discover the aptitude of an individual for a certain kind of work or training. Numerous tests have been devised to select workers in particular fields, notably typewriting, telephone operating, and other mechanical pursuits. Especially to be noticed here are the tests designed to select the aptitudes for musical performance. Seashore has developed a battery of tests to

discover the acoustic sensitivity of individuals. For this purpose he has developed tests for pitch, intensity, time, and consonance discrimination, while Schoen has worked on such aptitudes as sensitivity for absolute and relative pitch, tonal sequence, and rhythm.

While it is not the intention of the writer to evaluate these methods it may be suggested that at least some of the investigations prompt the question whether it is really traits that are being studied. While it is undoubtedly true that in many cases the investigation does reveal actual behavior equipment of the individual, in some instances the tests result only in ascertaining that the person under such and such conditions has performed a certain kind of reaction. The question arises whether such action is typical of the individual or whether it represents merely a contingential form of behavior.

C. Measurement of Traits.—The primary instruments for the measurement of traits are, of course, the well known psychological tests, for example, the Binet-Simon, the Army Alpha and Beta, etc. The fundamental principle of such measurements is to compare individuals on the basis of certain accepted criteria. Just as the investigations of trait discovery have inclined toward moral, social, and emotional traits, so the measurement type of investigation has been concerned mainly with intelligence responses. The fact that informational or intelligence results can be more easily compared is responsible for this situation. This view is further fortified by the fact that measurements have also been concerned with various kinds of mechanical performances.

In concluding this section on personality investigation we must point out that since it is naturally impossible to separate completely the different motives and interests that actuate the work on personality, the different types of investigation are therefore not entirely distinct. For example, in making a personality analysis the motive of measurement is not entirely excluded, while the measurement of traits must inevitably involve the discovery of specific traits and in general also run into the procedure of general personality analysis.

CHAPTER IX

ATTENDING TO STIMULI

Getting into Psychological Contact with Objects

Psychological organisms are never inactive. They are continuously performing responses to things. On the other hand, individuals are usually surrounded by many objects and situations. Thus the question arises how does the organism come into psychological interaction with any particular object. This process of beginning a psychological interaction or event is what is meant by attending. Now we know that a psychological interaction consists of the operation of a stimulus function on the one side and a response on the other. When I attend to something, therefore, some particular object becomes a stimulus for me.

We may conclude then that what the organism does when it attends to some object is to "actualize" its stimulus function. As I write these words I am handed a telegram. That sheet of paper immediately becomes a stimulus for me. Next I react in turn to each word typewritten on that paper. And finally I must respond to the question whether any answer is demanded. The adjustment to each of these objects presupposes that it has stimulated me. Since we can analyze a number of behavior segments out of this one situation, I have therefore during those few seconds actualized a series of stimulus functions.

Because psychological behavior never ceases, the actualization of stimulus functions must of course be an unending serial process. But the stimulus functions thus actualized do not necessarily inhere in different objects.

Study the drawing in Fig. 19. Your first reaction will no doubt be a response to the drawing of a brain hemisphere. A more careful scrutiny results in your actualizing another stimulus function. Now you are responding to the convolutions of the brain. Upon continuing your interactions with this drawing you actualize the stim-

ulus functions eliciting the acts of perceiving and enjoying the "children of the brain."

Attending Reactions are Preparatory and Auxiliary

ATTENTION IS PREPARATORY.—When we studied the pattern of response in Chap. 2 we discovered that it is an attending reaction system that always initiates interactions. The attending act prepares the organism for further action by determining that this object rather than some other shall be perceived and finally reacted

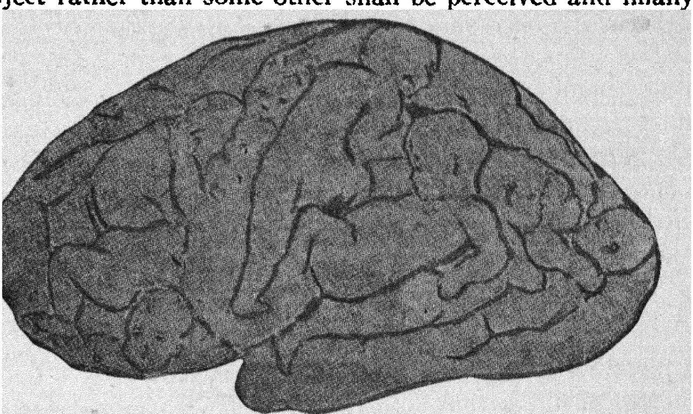


Fig. 19—Gudden's "children of the brain," illustrating the successive actualization of stimuli. From Titchener's *Textbook of Psychology*, by permission of The Macmillan Co., publishers.

to. We must attend to things before we can discern their nature, and obviously before we perform a final reaction to them. Although in many cases the attending and perceiving reaction systems appear to operate simultaneously, the accompanying diagram probably represents the situation faithfully.

S.	M.	A.	P.	F.
Stimulus ⟷	Operation of Medium— upon person	Attending act— stopping other action, set for new action.	perceiving— act	final act

ATTENTION IS AUXILIARY.—Attending reactions operate to make adaptations possible, but are not themselves adaptation acts. Attention is therefore an auxiliary act, a process of facilitating the performance of new responses. Accordingly, the attending reaction

system stands out in stark contrast to such adjustmental acts as any form of manipulation. At most one could describe attending action as stopping what one is now doing in readiness for some other act. We might also say the attending individual is shifting from one object to another, although he may make no definite movement toward or away from those things.

The auxiliary character of attending reactions suggests why they are such subtle forms of action, and why they constantly elude observation. Especially is this the case when we attend to thought objects (ideas) instead of performing more overt actions, or when we are passive observers as in the case of witnessing a stage performance. But even when attention responses precede gross movements or manipulations we find it most difficult to distinguish the attending from the perceiving reaction system.[1]

Despite the preparatory and auxiliary character of attending acts and their subtlety of operation we must still regard them as definite behavior configurations. They comprise particular sets of reactional components like all other behavior units.

Why Do We Attend to Things?

Unless we attend to things we cannot, of course, enter into psychological interaction with them. But why do some objects appear to be preferred? The general answer is that we can only enter into psychological interaction with things when they are available. I must either come into the presence of things as when I walk among the pictures in an art gallery, or they may come into my field of action as when a car looms up on the road. This we may call physical availability. Objects must also be available in the sense that they have had a place in my reactional biography.

Now there is a more specialized question to be answered. Why does one attend to a particular thing when a number of objects are available? The answer, of course, is that there are always certain conditions favoring one interaction rather than another.

A. Object Conditions

MOVEMENT.—On the whole, moving things are more likely to stimulate our attention than stationary ones. The movement of

[1] For instance Dallenbach and other psychologists have concluded that what has always been called the range of attention is really the range of apprehension.

objects greatly increases their chances of entering our behavior field. In many instances it is quite impossible for us to interact with things unless they do move. When we consider how difficult it is to make someone see a protectively colored insect upon a leaf or twig, we realize the advantage a moving thing has over stationary objects of becoming a stimulus.

CHANGE.—As long as the clock keeps running we have no occasion to react to it. But when it stops ticking then we are forced to actualize it as a new stimulus. It is just such changes introduced into our surroundings that bring about attention actions. The variations in the pitch of a whistle make us interact with it rather than its absolute sound.

INTENSITY.—Here is a roomful of students diligently writing an examination. Naturally there are numerous sounds going on. But if someone should drop a box of crayons the comparatively greater intensity of this sound will surely tear the writers away from their tasks. The effect of an explosion in forcing itself upon us as a stimulus object, no matter what we may be doing at the time, excellently illustrates the effect of intensity on attending conduct. Strong odors and intense lights likewise have a special potency in initiating an interaction with them.

REPETITION.—Sounds that are repeated are far more effective than unrepeated ones, when other conditions such as intensity and pitch are equal. Just how many times you must call me before I answer depends upon how absorbed I am at the time. The repeating alarm clock illustrates how many times a stimulus object must be presented before it is actualized and further responded to. We must notice, however, that repetition may obliterate the factor of change which is important for attention.

PROLONGATION.—The child who continues tugging at its mother's skirts appreciates the necessity for prolonging a stimulus in order to bring about the mother's response. Advertisers claim that it is this principle they employ when they continue the display of a slogan or a trade mark over a long period of time.

RELATIVE SIZE OF OBJECTS.—When newspapers print unusually large headlines they are presenting materials which will have a decided advantage over others in being read. Similarly when we

drop a watch screw we stand a much smaller chance of finding it than an ordinary wood screw.

Striking Differences.—Of the many objects competing for our attention those possessing the following qualities have the advantage: clearness rather than confusedness, definite outline rather than vague or intricate organization, novelty and peculiarity as over against stale commonness, importance and value as contrasted with indifferent and unimportant matters.

The student will notice that these attentional conditions do not, like some of the others already mentioned, depend upon properties of things which are independent of the person. To a considerable extent the objects have become endowed with these qualities through former contacts with persons. It follows then that these attention determiners are powerful only for certain individuals. We turn now to conditions which involve primarily the organism or person.

B. Personality Conditions

Reactional Biography.—Since the question as to what objects are novel, striking, or important is clearly dependent upon the individual's previous contacts with them, it is clear that the reactional biography of the person greatly influences his attentional behavior. Natural objects will not be attended to unless we have previously seen them and learned of their existence. It is this same lack of experience that sends us to the mechanic to find out what is wrong with our automobile. Because of his previous experiences with cars each peculiar and foreign sound attracts his attention whereas it produces no effect upon us whatever.

Personality Equipment.—How the general interests that constitute a large portion of our personality equipments determine what objects we shall attend to is demonstrated when we observe a number of individuals in their first attack upon the morning newspaper. You can diagnose fairly well whether you have before you a sportsman, a stock-broker, a politician, a bargain hunter, or one whose interests are no more profound than the comic strip. Again, note how quickly the purist is affected by an expression of bad grammar which passes unnoticed by the person having no interest in grammatical niceties. Also, it is the music instructor's concern with artistic perfection which makes each false note become actualized into a stimulus for comment if not complaint. Habit equipment,

too, determines that the workingman shall be sensitive only to the sounds and sights involved in his own work, while disregarding the multitudinous dins of a boiler factory. What one knows also determines very definitely the kind of things that are attended to. The physician with the widest knowledge of a certain disease is the one who is most easily attracted to the symptoms necessary for its proper diagnosis. The advantages of a woodsman in following a trail lie precisely in his superior knowledge. What other persons obliviously pass by arouses his attention at once.

Interests of the Moment.—When I need some tooth paste I find that it is the advertisement announcing just such a product that attracts me in the trolley or subway. When we are expecting a telephone call we are especially attuned to the ringing of bells. These facts illustrate how the immediate interests of the moment determine with what objects we shall interact. It is only when we contemplate purchasing an automobile that we become aware of the existence of the detailed features of various makes of cars.

Personal Circumstances.—The health, fatigue, worry, excitement, and depression of an individual likewise have a tremendous influence upon the kinds of objects which he actualizes into stimuli. Indeed some of these conditions may prevent the individual from entering into behavior interactions with any kind of object at all. This is the case with the extreme melancholic who is totally indifferent to everything. A similar circumstance is the preoccupation of the individual. We have innumerable anecdotes of musicians, artists, and scientists who become so absorbed in their work that they are entirely insensitive to the demands of any other object or situation.

C. Combined Conditions

When things are striking and conspicuous, and the person is at the same time interested in them, we have an illustration of an attentional act which is doubly determined. Think of the fisherman who is about to land a large trout. On the one hand, there is a tremendous interest in the fish and the final outcome of the attempt to get it into the creel. On the other, there are momentous happenings going on at the other end of the line. In consequence it is impossible for the fisherman to miss the slightest movement of the trout or any possible change in its conditions. Each one of these circumstances cannot fail to be actualized into a stimulus.

The double determination of attention is also illustrated by the person who becomes tied up with a thing because of its organization or composition. Take the "children of the brain" drawing. After we are in contact with the large outlines of the object depicted, we are inevitably led to actualize its smaller details into stimuli and consequently react further to them.

Conversational activities illustrate another form of dual attentional influence. Entering into a conversation means that we are interested in what is being said, while at the same time the words uttered take on a certain importance in the situation. To a certain extent it is true also that the other person forces his stimulus objects upon us. Consequently each verbal action necessarily becomes actualized into a stimulus.

Social and Psychological Attention

ATTENTIONAL POSTURES.—Consider the soldier standing at "attention," or the track runner posed on his mark "attentively" awaiting the gun. Are these expectant postures genuine attention acts? There is no doubt that the answer must be no if by attending we mean a strictly psychological action. It is clear that instead of being subtle preparatory reaction systems such postures are final adjustmental acts. Since we cannot modify the linguistic usage which names such acts attention it is advisable to distinguish sharply between genuine psychological and social attention.

We must hasten to add that attentional postures are very closely connected with genuine attentional behavior. Thus the attentional posture constitutes an act of preparedness for actualizing some stimulus function. When the officer demands attention he is commanding his men to be ready to actualize a new verbal stimulus function in order to make sure of properly perceiving the impending command and consequently to execute it properly. Each attentional posture reaction therefore must, as a factor in a behavior pattern, be preceded by an actualizing reaction system. This fact can be illustrated by the accompanying diagram.

S ⟷	Actualizing ——	Perceiving ——	Final
The verbal command "Attention"	(rs)	(rs)	Attending posture (rs)

SUSTAINED ATTENTION.—This term stands for another type of social attention. Of the superior student it is said that for hours

on end he can uninterruptedly attend to his studies. Here attending is synonymous with the popular term concentration, which means persistency in studying or reading. This form of social attention is also intimately bound up with genuine attention reaction systems—namely, with the great number of actualizations of stimulus functions which precede and initiate the various acts of perceiving words and sentences.

INATTENTION.—It is an interesting paradox that the behavior which is popularly called inattention or lack of attention really involves genuine attention action more intimately than either "sustained attention" or "attentional posture." When the teacher asserts that the child is not attending she only means to say (in strictly psychological language) that the child is actualizing other stimuli than those to which she would like to have him react. Obviously, the teacher is speaking only of a social situation. Unless the child is in a state of dreamless sleep he cannot even for a brief second fail to actualize stimuli.

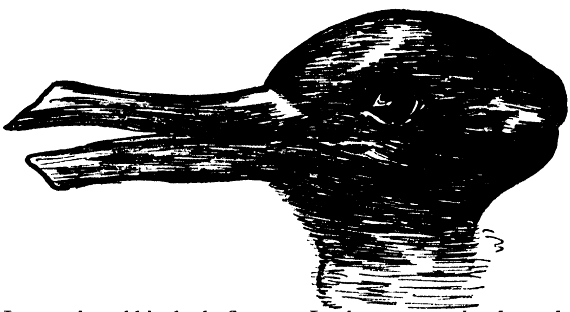


Fig. 20—Jastrow's rabbit-duck figure. Is there any stimulus selection?

Behavior Effects of Attentional Activities

There are several ways in which attentional activities serve to influence an individual's general behavior life.

ATTENTION SYSTEMATIZES CONDUCT.—Because what we perceive and adjust ourselves to is determined by a preceding attention act our interactions are orderly and systematic. It is for this reason that psychologists have traditionally defined attention as a selective action. This appearance of selectivity is really a matter of serially or successively responding to things as we have already observed. Look at the rabbit-duck figure (Fig. 20) and it will appear evident

that although two stimulus functions are successively actualized they are not really selected.

One might just as well call attentive behavior inhibitive. Though we are surrounded by a veritable inferno of noises as when walking under the elevated railway, we can still hear our friend's question. Say we select his words or inhibit everything else, as you choose; but if we were preoccupied and not attentive it is evident that we could not carry on a conversation.

Attention Makes Behavior Effective.—A and B are stargazing. A sees a star that escapes B altogether. Now in order to make B see it A forces him to attend to it. By A's persistent effort in pointing it out B finally actualizes the object into a stimulus. Thereafter B can study and admire it with great facility. Another illustration we find in the common observation that if we have followed an airplane or bird in its continued flight we can see it long after it reaches a point of normal invisibility.

Our point may also be exemplified in the field of auditory conduct. As Titchener points out, two persons engaged in conversation can still hear and understand each other even after they have become separated for a distance beyond which an unexpected question would be inaudible.

How Long Does the Attention Reaction Last?

This question receives three distinct answers because it really refers to three different kinds of facts—namely, (1) the specific process of actualizing a stimulus function, (2) attentional posture, or (3) sustained attention.

(1) The process of actualizing a stimulus function of an object occupies only the briefest part of a second. That is why the process is so difficult to observe. But we recall that the actualizing of a stimulus is only a preparatory action auxiliary to the more definitely adjustmental acts of the person.

(2) When we inquire concerning the duration of the attentional posture we get a different answer altogether. Instead of a fraction of a second the figure grows into many minutes. A good way to account for the difference in time here is that when the soldier stands at attention or when the runner is set on his mark he is not merely doing one thing. The person in these situations is

before the divine Judge. As we have said, this time duration may be measured in hours.

To How Many Stimuli Can We Attend at Once?

Here is another question that requires different specialized replies. If we ask how many stimulus functions can be actualized at once the answer is probably only one, and especially when the functions we are talking about reside in different objects. Perhaps it is impossible simultaneously to enter into interaction with two entirely distinct things. But when the stimulus functions reside in the same object we can probably actualize two or even three in the same interval. Thus we can at one and the same time attend to the sight and sound of an object. When one person talks to another he can simultaneously interact visually with the lip movements as they change form, and auditorially with the sounds that are made. When we actualize a single stimulus function in a number of objects, as when a distant crowd stimulates us to notice its existence or observe its movement as a unit, then we are interacting with a large number of things at once.

Doctors often disagree. Since we have here a single behavior segment, namely a single stimulus function and response pattern, some psychologists are inclined to say that the crowd consists of only one thing. To quarrel about this point is easy but unprofitable. We merely suggest that we keep things distinct from the stimulus functions that inhere in them.

The question of how many stimuli we can actualize at once must not be confused with the very different one of how many acts we can do at once. The latter question refers to conduct in the everyday use of that term. The anecdote concerning Cæsar's ability to dictate to several copyists at the same time is often repeated. Chess players can play many games at once. The typist can look at her copy, strike the keys, chew gum, and hum a tune at the same time that she is musing upon the play she saw last night. Unquestionably we have here numerous attentional reaction systems in successive operation. So far as the strict attentional performances are concerned there is a continuous shifting from one thing to another. One unit of action is started off and it continues until complete. Then when a new behavior segment begins it must be initiated by a new attentional action.

Forcing Attention

Since attending is a preparatory act of actualizing a stimulus function and because it is an instantaneous affair, our attentional behavior is quite aptly described as mobile and shifting. Now as long as we have plenty of stimulus functions to actualize in a single object, as in our Last Judgment picture, or single functions in many objects, we can force ourselves to attend to them. In other words we can sustain our attention or maintain attentional postures.

But what happens if we are limited by the stimulus objects? Suppose that only a few stimulus functions are available. Then we are reduced to a simple process of constantly alternating our attention from one to another.

Attentional Alternation.—A simple demonstration. Fixate a spot on the wall. See how long you can keep attending to it. You find, do you not, that you can "stick" to this thing for only a very limited time. If you persist in looking at it you find yourself shifting from the wall to the spot and back to the wall again. Attention is here limited to the alternate reactualization of the stimulus function of the spot over and over again. If we continue to do this for a long time we will no doubt shift from the object before us to various ideas. And here the field of interaction is unlimited. If this kind of attention shift cannot occur we will probably go into the kind of hynotic trance which crystal gazers practice.

The result of forcing attention can be well observed by examining ambiguous figures or objects with reversible perspective (Figs. 22, 23, 24, 25). Here the dual or trial nature of the objects favors, if it does not compel, a more or less rapid alternation of interaction between their various aspects.

One of the best demonstrations of the alternation of attention is provided by the phenomenon of binocular rivalry. By means of the stereoscope (Fig. 26) a green field and a red one, or a plain field and a patterned one, can each be placed before one of the eyes with the result that if we continue to respond to these visual fields we must do so successively. A constant oscillation of responses to the different objects occurs.

Attentional Fluctuation.—Place your watch at such a distance from where you sit that you can only faintly hear it tick. Now persist in attending to the sound. The result of forcing atten-

tion to this very meagre and limited stimulus object is that the sound seems to pass out of range altogether.

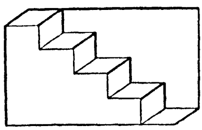


Fig. 22—Schröder's figure — cornice or steps?

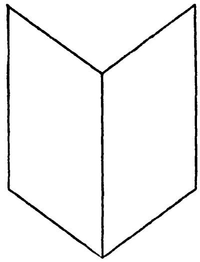


Fig. 23—Mach's book. Are you looking at the back or the pages?

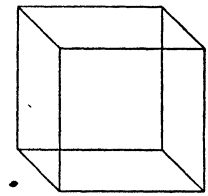


Fig. 24 — Locate two sets of planes.

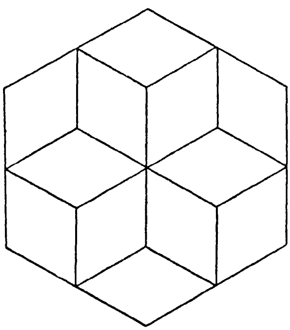


Fig. 25—The psychological three-in-one.

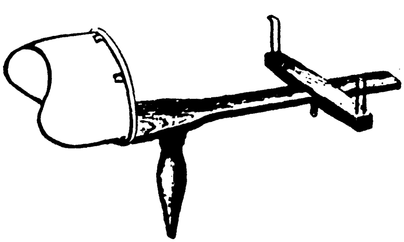


Fig. 26—Simple hand stereoscope.

Some Experimental Studies of Attention

Actualizing Attention.—So brief and subtle an act as the actualization of a stimulus function is necessarily difficult to experiment with. Experimental studies are therefore mainly restricted to

sustained attention. Titchener,[2] however, refers to an experiment which illustrates the effect of momentary interests upon the actualizing of a stimulus.

In Fig. 27 is a bell-metronome to which is attached a cardboard upon which is drawn a graduated arc. The degrees indicated are traversed by an arrowhead pointer attached to the end of the pendulum. The bell is set to ring at 22° after a full oscillation requiring a little over a second. The subject is instructed to observe what point the indicated arrow reaches when the bell rings.

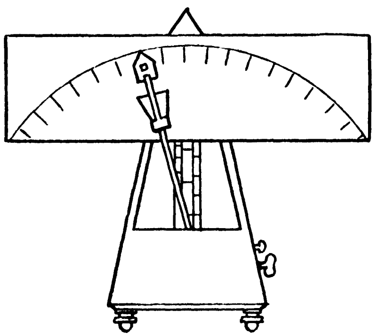


Fig. 27—Titchener's metronome scale apparatus for illustrating the influence of momentary interest upon attention. From Titchener's *Textbook of Psychology*, by permission of The Macmillan Co., publishers.

Now there are two results. When the subject attends primarily to the pointer he reports the bell at about 30°, that is to say about 8° after it actually sounds. On the other hand, if he is instructed to watch for the bell he reports it when the pointer is between 10° and 15°, in other words as much as 10° before it rings. In both cases the momentary interest interferes with the person's proper actualization of the stimulus function or with his report about it.

Postural Attention.—Woodrow[3] designed a postural attention experiment by varying the interval between his "ready" signal and the presentation of the stimuli in the reaction-time behavior. This experimenter presented his stimuli at intervals of 4, 8, 12, 16, and 20 seconds in an irregular order after he gave the ready signal. The results show that the 12 second interval is the best in the sense of yielding the shortest reaction.

[2] A Text Book of Psychology, Macmillan, 1912, p. 297.

[3] The measurement of attention, *Psych. Mon.*, 1915, 17, 16-65.

SUSTAINED ATTENTION.—An experiment designed to test the individual's capacity for sustained attention is illustrated by Morgan's[4] work on distraction. While the subject is busily tapping keys like those of a typewriter as a response to a set of stimuli presented in a particular order, distractions like a buzzer, fire-gong, and phonographic music are introduced in the otherwise quiet room. The result shows that while at first the extraneous sounds seem to slacken the speed of the subject's work they later accelerate it even beyond the rate prior to the introduction of the distractions. Apparently the subject can compensate for the distraction by exerting greater effort.

That sustained attention and attentional postures are somewhat advantaged by doing some sort of exerting task at the same time is illustrated by an experiment of Bills.[5] A number of subjects were put to adding and memorizing nonsense syllables while they simultaneously squeezed two dynamometers. While moderately squeezing the instruments their performances were more efficient than otherwise.

[4] Described in *Arch. Psych.*, 1916, no. 35.
[5] *Am. J. Psych.*, 1927, 38, 227-251.

CHAPTER X

PERCEIVING INTERACTIONS

The Appropriateness of Responses

By this time the student appreciates the utter complexity of psychological conduct. Even so simple a performance as crossing a brook consists of a large series of behavior segments. Moreover, if the person is to get across successfully, each response pattern in every behavior segment must be precisely coordinated with its specific stimulus object. Unless I step upon this projecting rock I shall get my shoes wet. Each final act must be preceded by precurrent reaction systems identifying the character of the stimulus object. It is such a precurrent reaction system that makes the final act appropriate to the stimulus object.

These precurrent identifying or discriminating reaction systems are called perceiving acts. When I discern the nature of an object, its meaning or significance, I am performing a perceptual reaction. Before I grasp a wire I appreciate its dangerous qualities, its power to shock me for instance. All complex behavior demands this prior realization of what a thing is as a necessary guide to further action. When the child is sent into the garden to get a rose, he must be aware that the object before him is a rose and not a dahlia.

Perceptual Behavior is Orientative

As our illustrations indicate, perceptual behavior is not in itself adjustmental. It is an indispensable factor, however, in every complex adjustment that the organism makes. In this respect perceiving acts are like attending responses. But the similarity goes no further. Whereas attending acts are merely reaction systems which result in bringing an organism and an object into psychological interaction, perceiving acts orient the person with respect to the object and its setting. As we have seen, it is because of this preliminary orientation that our adjustments are properly performed,

and for this reason the orientation action is tremendously important for psychological conduct. It means that when an individual becomes oriented he is more or less detached from the stimulus object. Such detachedness allows for a degree of independence in the person's behavior. He can do one of many things to, or with, the object.

Compare for instance the complex response (behavior pattern) which includes a precurrent perceiving act, with the reflex response which does not. The latter, as we know, consists of a single reaction system. Hence in performing a reflex response the person can do only one thing as determined by the qualities of the object with which he is in immediate contact. One can do nothing else but draw one's hand away from a hot object. When the response includes a perceiving act, on the other hand, the individual, because he can size up the situation beforehand, has an opportunity to interact with it in a much more adequate way.[1] If I can avoid the sour taste of a fruit that I perceive, I am not therefore at the complete mercy of the stimulus object as in the reflex situation.

There is something more. Perceiving acts are semi-implicit. In performing a perceiving response we do not merely react to a thing as it stands before us, but rather to what the object means—in other words, to its possibilities as a behavior object. The boy confronted with an orange perceives it as something more than a bit of fruit. It is something to throw, and so when the need arises he perceives it as a ball. Because of his orientation to that object he will not, however, throw it as hard as he does his baseball.

What Kind of Reactions Follow Perceiving?

Perceiving acts are not always followed by overt adjustmental acts. Almost any kind of act can consummate a response pattern. When I perceive a stone in my path I may not kick it, but merely wonder how it got there. Perceiving an object may likewise be followed by verbal action, as when seeing my papers disarranged I exclaim, "Who did that?" or by the consummatory reaction of musing upon the perpetrator thereof. In still other behavior segments the perceiving reaction system is followed by feelings of all

[1] The student will notice that as a matter of fact the two kinds of behavior situations are usually not comparable, and each response is better fitted for its own situation; still the comparison does inform us concerning the nature of the perceptual act.

sorts, or quite definite knowledge or speculation acts. Upon catching sight of a beautiful painting I may immediately become suffused with the warmth of keen delight or speculate as to who created it. Too, the response pattern may be very complicated and include between the precurrent perceptual act and the consummatory adjustmental act a large number of overt and implicit reaction systems.

Perceiving Behavior Rooted in Reactional Biography

How does it happen that as soon as an object becomes a stimulus for a person he can react to it meaningfully? To answer this question we must study the person's reactional biography. When we do so, we find that as soon as he is confronted with an object he realizes what it means because in his former contacts with it he has discovered what its qualities are and also what he can do with it. In this succession of interactions with an object it has taken on a series of particular stimulus functions. Now the person is able to react to the thing as a complex of various characteristics. As soon as he attends to it he realizes at once its interactional possibilities, and in particular its significance for his immediate behavior purposes. In the following paragraphs we examine some reactional sources from which perceiving acts are developed.

Reflex Behavior.—In the granary of popular expressions time has deposited the aphorism that the burnt child dreads the candle. As in the case of so many wise sayings this one, too, can be made to tell a tale. Let us analyze out of it the psychological story of perception. The child accidentally comes into contact with the candle flame. Immediately there is a jerky, withdrawal response which constitutes the typical reflex interaction. Now if the painful consequence of touching the candle results in the appreciation that it is the candle flame which caused the pain, the candle flame has acquired the stimulus function for the child of keeping his fingers out of it. Henceforth he perceives it as a painful thing. What this amounts to is that whenever the child sees the candle flame the seeing action is not followed by putting his finger into it. The basis of the whole process is the organization of a visual and a non-touching act.

Ecological Discovery Situations.—As we have observed in Chap. 5, the early behavior life of the child consists to a great

extent of exploring his little world. During his investigative enterprises the child discovers that both this red apple and the other orange colored sphere can be rolled. Whenever, then, a rolling object is desired, he can choose either one or the other for his purpose. Both the apple and the orange then mean to him rollable things. Whenever he attends to an apple, therefore, he is aware of what he can do with it.

Further exploration of these objects results in the development of more perceptual reactions to them. The child discovers that they mean something more than rollability. Both objects are soft enough to be bitten into. Here is another significance they have. But having bitten into the apple or the orange, he discovers that the apple skin is not unpleasant to taste whereas the skin of the orange is. On second contact with these objects both have additional meanings for the child in the sense of conditioning his further behavior to them. Hereafter these objects elicit in the individual numerous orientational or knowledge reactions which we call perceiving conduct.

Instructional Situations.—Not all qualities or meanings of things are developed through direct personal interaction with them. Our perceptions can be mediated by instruction. For example, the individual is told that this blue colored fluid will kill him if he drinks it. Instruction thus serves as a form of indirect experience with this object. The result may be the same as discovery *in propria persona,* since a perceptual meaning reaction is built up. In this particular illustration the present perceptual contact with the fluid gets connected with the negative reaction system of not drinking it, or the positive reaction system of avoiding it. The child learning his letters illustrates the development of perceiving reactions through instruction. He is told that this letter is *a,* this one *b,* this one *x,* etc. To each letter as seen is connected a vocal act producing a particular sound. When the child is able to connect the proper sound with the letter, then he perceives and names them correctly.

Adult Experience.—It is a wrong impression that perceptual responses originate only in the early periods of reactional biography. Throughout the entire behavior life of persons, objects take on both first and additional meanings. An example of inevitably developing new perceptual responses is found when new things come into existence through invention, or when new natural objects are

discovered. In adult contacts with things the perceptual meanings derived are not necessarily limited to the sheer identification of things, but refer also to their serviceability, use, and values.

Perceptual Development a Continuous Process

That perceptual reactions develop from adult experiences as well as from infantile periods of reactional biography suggests at once that the person is constantly acquiring perceiving behavior. The naturalist admonishes his students to study a frog until they see all its essential features. Even when they report to him that they perceive it thoroughly, he sends them back again and again to their observations until their perceptual responses are really adequate.

What happens in such a situation is that the observer develops more and more meaning reactions to the object while it correspondingly acquires additional meanings or stimulus functions. The result is, of course, that an increasingly effective series of interactions is made possible.

As a consequence of such enrichment of our perceptual experiences we achieve greater and greater possibilities for interacting with objects and situations. Consider the art student in his first contacts with a painting. In the beginning his perceptual responses to a painting represent an accumulation of meanings developed in pre-artistic situations entirely like those of any other person. With his continued studies, however, he perceives the picture in addition as a product of a particular technique, as the work of a certain school, and as a particular approximation to aesthetic perfection. The student of science likewise illustrates this perceptual development. At first he perceives things as do all other individuals. As he advances in his study, however, he discovers further characteristics of objects until finally when he looks at them they mean infinitely more to him than they do to those who have not studied them.

Perceiving Comprises Different Behavior Configurations

We have learned that when we perceive an object it stimulates us to appreciate its meaning. We realize what we can and cannot do with it, what good or evil results will follow from touching it,

etc. But now the question arises: what is the actual behavior configuration of the person when he perceives something?

Of one thing we are very sure—namely, that there are a large number of perceptual configurations. This is only to be expected, since we not only perceive many different kinds of things, but our reactional histories vary tremendously.

In general, however, the perceptual behavior configuration is a vestige of some previous action. Why does the child discern in this orange a ball as well as a colored sphere? Is it not because the orange arouses in him a vestigial remnant of the former act of playing with it?

Pavlov happened upon an experimental demonstration of this phenomenon. He found that placing a piece of meat before a puppy several months old produced no salivary reaction. We may say that the animal did not perceive the object as meat. When it was placed in the animal's mouth the normal salivary response naturally occurred. Thereafter whenever the animal smelled or saw the meat it performed the characteristic reaction of a dog to such an object. Now because the meat excites the same reaction in the animal as before, it appreciates the nature of the object. Although the dog's later responses consist of the complete repetition of the original act rather than vestigial parts of it, the experiment certainly indicates how perceptual meanings originate and operate.

In most cases the perceptual reaction systems are very subtle and hard to observe, but in others they are easier to study. Among the latter are incipient acts. We perceive an object as heavy because we incipiently strain and push; we perceive something as dangerous because we begin to dodge and cringe. Sometimes these incipient actions are describable only as a readiness to do something; in any event the perceptual behavior configuration is a definite kind of action.

It is to be expected that only when the original situations involve definite movements will they also be found in subtle perceiving actions. When perceiving reactions are built up out of overt behavior we observe that the person repeats in a slighter form what he did when he originally developed the perceptual action. In such cases as perceiving letters or words we often find a slight tendency to pronounce the name of a thing.

No matter how gross or how slight the perceptual behavior configuration is, it is of course an action of the entire organism. And

yet when we describe such reaction systems we may be obliged to emphasize the action of the hands or feet, of the eyes, ears, or the head generally, or perhaps even some visceral action.

Perceiving Acts Vary in Orientational Quality

It is only natural that the person should have different kinds of experiences with things. Accordingly his perceiving acts differ in complexity, and in autonomy or intimacy of connection with a consummatory act. We may attempt to differentiate different types of perceiving acts under the following headings.

Primary Perception.—This type is the simplest of all. Primary perception consists of a simple discrimination of the qualities of objects. As such it is not far removed from the sheer differentiation that characterizes all psychological phenomena. In primary perception the meanings of things are meagre and amount only to an identification of their character. The infant perceives the burning candle as nothing more than a harmful thing. Such a perceiving act merely conditions the occurrence of a single elementary consummatory reaction system. Moreover, the consummatory hand-withdrawing action is a vestigial remnant of the previous action of jerking away from the flame. It is for this reason that the behavior segments containing primary perceiving reactions are fairly automatic in their operation, as the diagram practically indicates.

Stimulus ←——→ attention act ——— perception act ——— consummatory act

Simple Apprehension.—When the individual discerns more than one meaning in a thing, he may perform one of several different types of consummatory actions. As we drive along the road at night our attention is attracted to a light. We not only distinguish it as an automobile headlight, but also as belonging to a recklessly driven car. What will our consummatory act be? We might suddenly put our foot on the brake or steer to the extreme right. Notice that the diagram indicates this type of perceptual reaction system may be followed by either consummatory action (1) or (2).

consummatory act (1)
Stimulus ←——→ attention act—perceptual act
consummatory act (2)

Complex Apprehension.—The child looks into the sack that the stranger holds out to him. "Ah, candy," is his instant discriminating reaction. But it is perceived as something more than the sweet and desirable thing that is being extended to him. It is something forbidden to him when offered by strangers. Now it is not a question of immediately doing one or another of two immediate acts but rather doing or not doing something. When the inhibition of an action is in question we may regard the perceiving responses as more autonomous than in the other cases discussed. That is, they allow a larger range of final acts. Complex apprehension thus involves not only the sheer identification of things, but also the appreciation of their uses and values, and whether or not they fit into the scheme of one's immediate purposes.

$$\text{Stimulus} \longleftrightarrow \text{attention act—perceptual act} \begin{cases} \text{consummatory act performed} \\ \text{consummatory act inhibited} \end{cases}$$

Comprehension.—We come now to the most complicated of all perceiving reactions. The comprehension form is completely independent of any immediate further performative response. Comprehension acts prepare the individual for comparing and contrasting things, for artistically enjoying, discussing, or speculating about an object. These are the most autonomous of all perceptual acts and operate like knowledge reactions, except that they must be performed in direct and immediate contact with some object. In attempting to diagram behavior segments in which comprehension responses are prominent, we leave vacant the place for the consummatory reaction system thus:

$$\text{Stimulus} \longleftrightarrow \text{attention act———perceptual act———?}$$

Many Kinds of Perceptual Stimuli

So far in our study of perceiving we have stressed the activity of the organism. We have learned that perceptual actions are precurrent reaction systems in the response pattern of behavior segments. We have also discovered that these behavior segments are analyzed out of large total behavior situations. We must now turn to a consideration of the stimuli which call out perceiving reactions.

The question is, in what do the stimulus functions inhere? We have appeared to stress the perceptual interaction with total objects, but it is no less true that we perceive their separate qualities. Furthermore, we may locate the stimulus function for perceiving reactions in things other than objects, for example in space, time, etc. We therefore enumerate some of the types of perceptual stimuli.

OBJECTS AND QUALITIES.—It is certainly true that we sometimes react to books, chairs, tables, or persons without especially discriminating the qualities in which they differ one from another. But just as often we may be interested in some particular quality, such as color, stability, or weight. Again, we are also sensitive to the beauty and loveliness of things. Our reaction to a flower may be directed toward its beauty as well as toward its color or fragrance. It may be the attractiveness and vivacity of a person that we perceive rather than any other quality. Furthermore, we perceive things as valuable or useless for particular purposes, as when we reach only for wooden blocks or bricks in order to jack up a car. We might add too that the qualities we perceive in things may belong to them originally as natural objects or may be attributed to them by the persons or societies which deal with them.

ACTIONS.—Before approaching a prospective buyer the salesman is told to be sure that the former is in a receptive mood. In psychological language this means that when a person is peeved or distraught, uncomfortable, bored, or angry, there is no use in trying to sell him anything. These are suggestions of the different kinds of acts which stimulate perceiving behavior. We may thus observe a person as happy, self-satisfied, depressed, exalted, and joyous, as anticipatory to engaging in further contact with him. All of these actions we perceive without seeing the individual in direct contact with stimulus objects. When we do observe persons directly interacting with objects we may perceive their behavior as fitting, inept, humorous, or grave. We hardly need to add that our perceiving responses are not limited to acts of persons but apply to the behavior of things also.

SITUATIONS.—Whenever we perceive the complex interactions of persons and things we react to situations. Seeing the train approach some obstruction on the track is a preparatory act to running ahead to flag the engine driver. Suggestions of the numer-

ous kinds of situation-stimuli are the lamentable, inevitable, dangerous, or desirable circumstances that we are constantly in contact with and to which we must further adapt ourselves.

Rhythm.—A special form of perceiving is the reaction to the accent or interval order of changes in objects. Here the stimulus function resides in the rate of change in movements and the order of appearance and disappearance of things. Rhythm is a matter of arrangement of happenings. In auditory phenomena there are the various orders of succession, as the accented or more vivid and unaccented or less vivid sounds in music and poetry. The electric sign with its alternate light and darkness, or more or less intense lights exemplifies the rhythmic stimuli for our visual reactions.

Words.—Because of the enormous and important place of speech and reading in human life, we must place special emphasis upon our perceptual actions to words. Perceiving printed or written words means to appreciate what they stand for. The consummatory responses of reading behavior segments consist of reference reactions. Perceiving the word "house" means that we appreciate its connection with a particular kind of building. This final reaction system is obviously of the implicit type and is very different from the action of merely pronouncing a word, which means performing an immediate overt final response.

Time.—There are four kinds of time stimuli. When we make comparative observations of two horses during a race we not only react to their actions, but also to *simultaneity* as a time element. They reach a certain point neither before nor after each other. *Duration* is perceived when we respond to a unit of time, or to a length of time as we popularly say. The duration is the amount of time that one horse will be in front of, beside, or behind the other. We are also stimulated by *intervals* of time, that is to say, successions of duration, or time changes. And finally we react to *frequency,* how many times one horse will put its right front leg forward as compared with the other animal.

Place.—In attempting to pass a car on the highway we must be able to appreciate how far ahead of us it is, as well as the distance of both it and our own car from the machine approaching in the opposite direction. The practiced driver perceives the distances at once and proceeds to pass the car ahead. This reaction to linear

space or distance exemplifies only one of the many forms of appreciation of where things are located. We perceive objects as here, there, up, down, near, far, farther, etc.

Besides our reactions to spatial localization we perceive things as distributed or extended in space. Thus we react to the sizes of things, their length, breadth, and height, as well as their shapes as variously spread out in three dimensions.

MOVEMENT.—Let us use our automobile illustration once more. When we wish to pass a car in front of us we must perceive first whether the car ahead on the opposite path is moving or stationary. But more than this we must perceive its rate of motion which is appreciated in terms of its change of position with respect to our car and other things close to it.

RELATIONS AND EVENTS.—When we perceive an automobile as moving with respect to other machines, or to a bridge, house, or person on the road, we are at the same time perceiving relations and events. Events may be defined as just such interconnection of actions among things. Relations are also perceived in situations which are not events. This is the case when we perceive things as merely connected in the same space and time. Here we perceive such relations as above, below, beside, between, etc.

Analytic and Synthetic Perception

Whenever we interact with such complicated things as objects in motion and in various relations we regard our perceptions as highly synthetic. We are responding to large organizations of things. On the other hand, when we respond to phases of events such as objects, their qualities and movements, and disregard the wholeness of which they are parts, we may properly speak of such perceptual reactions as analytic acts.

Here again arises the question, in what does the perceptual stimulus function inhere? It turns out then that synthetic perception consists of responses to multiple inherence stimuli (perceiving a garden as a unified mass of color), whereas analytic perception involves a unit inherence stimulus function[2] (perceiving only one type of flower at a time).

[2] See Chap. 2, p. 31.

Perceptual Behavior Subject to Various Influences

Despite the fact that perceiving reactions are always stimulated directly by the objects present before us, it is no less true of them than of other psychological activities that they are subject to the law of individual differences. The psychological basis for this fact is that our perceiving reactions are conditioned by various circumstances. True enough, things are what they are no matter how we react to them, but they stimulate persons differently. Because these circumstances influence both the development and the later operation of our perceptual behavior we must examine both the developmental and operational conditions.

A. Developmental Conditions

Biological Influences.—The biological conditions of the individual determine whether or not he will develop certain perceiving acts at all. Because of the inherent defectiveness of his retinae the color blind person cannot discriminate between the color qualities of things. There are various forms of color blindness. Some individuals cannot distinguish between red and green objects; to others blue and yellow things look alike, while still others are unable to discriminate either blue or any color at all. Similar biological deficiencies may deprive persons of the capacity to distinguish between sounds or odors.

Influences of Reactional Biography.—Although one's biological equipment is complete and normal, opportunities for contact with objects are essential for acquiring perceiving reactions. Such influences facilitate or retard one's perceptual development. Tell an elementary student in zoology to discover how a paramecium swims. He looks through the microscope but does not perceive the swimming mechanism. However, when you explain to him that it consists of the vibration or lashing of cilia (hair-like structures) projecting from all around the periphery of the organism, his peerings through the microscope yield better results. He has become trained to perceive. Another example. No matter how hard the young medical student may try to differentiate the sounds of the heart beat or how fine a stethescope he may use, the sounds are not there for him. Further training, however, produces excellent results. Similar complicated training procedures are necessary to develop the fine perceptions of the tea or wine taster.

B. Operational Conditions

Assume that the individual has built up a large equipment of perceiving reactions, even with respect to the same objects. The question then arises which of these will operate at a given time. There are many conditions to influence how we shall perceive an object or whether we shall perceive it at all.

FATIGUE.—Every student has had the experience of persisting in reading until he is unable to say what the sentences that he pronounces vocally or sub-vocally mean. This condition under which the efficiency of one's work becomes diminished or reaches zero is undoubtedly due to attending ineffectually because of fatigue. The person may either attend sufficiently to perceive well enough to pronounce but not understand what he reads, or he may not even be able to see the printed material before him at all.

CONCURRENT RESPONSES.—Which kind of perceiving reactions will be elicited at any particular moment is very definitely conditioned by what else the individual happens to be doing at the time. When the person is told something while in a blue or depressed mood, he will perceive the words as having a very different meaning than when he is in a buoyant state. Wants and desires similarly have their effect upon what the individual perceives. When we require the book located on a high shelf, we see the chair as a ladder. The same chair we may perceive as a table when we need a place upon which to set something.

INTEREST.—The influence of interest upon our perceiving actions is well illustrated in the following experiment. Mix up a number of small cardboard squares and circles of various colors. Tell someone to separate out as rapidly as possible the different figures and when the task is done ask what the different colors were. You will find that being interested in the figures the person did not perceive the colors.

The influence of interest upon perception can be well illustrated by comparing the superficial and the more profound levels of interest. Look at Figs. 28 and 29. A superficial interest will be responsible for the surface apprehension of one kind of thing whereas a more profound interest will result in the more complex apprehension of the less easily discernible object.

A further influence of interest upon perception is available in the observation of psychologists that when expecting a person at the station exit one will interpret several individuals as the one awaited. Again, when expecting a visitor various kinds of sounds will be perceived as footsteps.

INTERACTIONAL SETTING.—As a final conditioning factor of perceiving reactions we may consider their setting or background.

Fig. 28—Rubin's goblet figure. We may regard our interest in the striking black figure as more superficial than the interest in the faces it forms in the background.

Fig. 29—Hill-Boring's My Wife and my Mother-in-Law. Our interest must be especially stimulated to perceive two faces instead of one. From American Journal of Psychology.

At one time my friend stimulates me to perceive him as a person whom I calmly greet and to whom I extend my hand for a conventional clasp. Upon another occasion I slap him vigorously on the back. What I do depends upon who else is present. There is a time for dignity and a time for exuberance. Likewise there is place and occasion for each.

Many striking influences of settings are observed in our reactions to words. Consider the following sentences contrived to exemplify this fact.

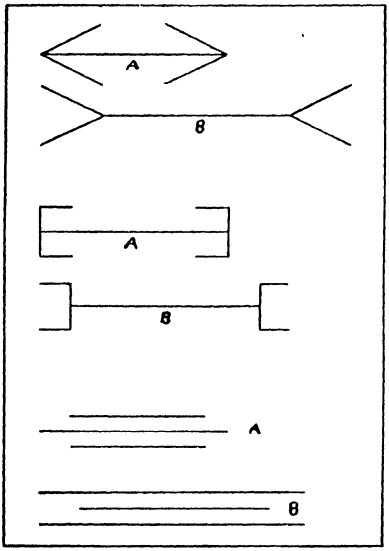


Fig. 30—Three forms of the Müller-Lyer illusion. Why should the lines marked A seem shorter than those marked B in each form?

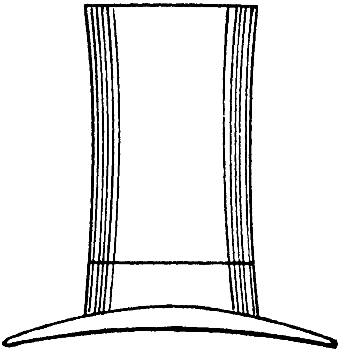


Fig. 31—The vertical-horizontal illusion of Luckiesch. Is the crown really as high as it appears? From *Visual Illusions and Their Appreciation,* courtesy of D. Van Nostrand Co., publishers.

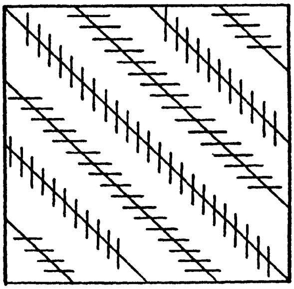


Fig. 32—The Zöllner illusion. Is it possible to see the long lines as parallel?

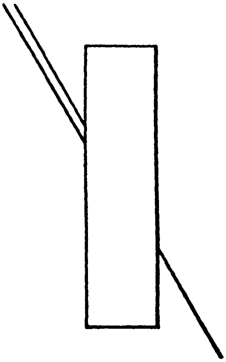


Fig. 33—The Poggendorf figure. Which lower line meets the upper?

Man sagt dass nicht *hell war* der *Tag* in dem er sich die *That* erlaubt *hat.*

That war is not *hell* in which a *man* only loses the *tag* off his *hat.*

We have italicized the words common to the two sentences. How we perceive them is absolutely conditioned by their respective German and English contexts.

Illusions or Perceptual Mis-reactions

Who faulteth not, liveth not. Psychological conduct no less than behavior in general is subject to inevitable error. We are constantly reacting to things as though they were other than they are. But

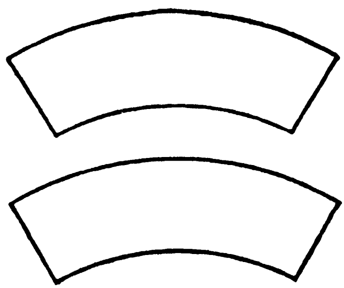


Fig. 34—Figure illustrating an illusion of area.

it is not sheer frailty that makes mis-reactions possible. Rather, illusions are based upon the fact that we respond to the meanings of things instead of only to that with which we are directly in contact.

The classic example is the reader's illusion. We read what ought to be in words rather than what the typesetter has actually put into them. Letters may be transposed or substituted for, but we read them as though they were correctly printed. The proofreader of the famous "Wicked Bible" read "Thou shalt not" although "thou shalt" was printed in the seventh commandment. Similarly, the printer who read vinegar as though it were vineyard is responsible for the famous "Vinegar Bible."

Everyone is familiar with visual mis-reactions, since from the time that illusions were first studied writers have persisted in devising illustrations of illusory responses. Figs. 30, 31, 32, and 33 illustrate various line illusions. Illusions of area are indicated in Fig. 34, while Fig. 35 illustrates an illusion of perspective.

Misreactions of moving objects are just as familiar. While observing the movement of a train on a parallel track we perceive our stationary train as moving. We likewise perceive the moon in motion whereas it is the clouds that are passing in front of it. Again when we stand on a bridge looking down upon the swiftly flowing current we perceive ourselves as moving.

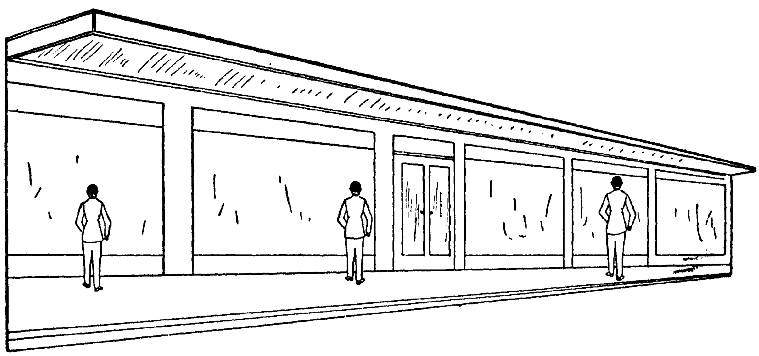


Fig. 35—The same sized figure seen differently through the influence of perspective.

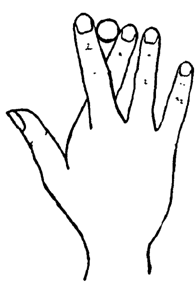


Fig. 36 — Aristotle's touch illusion.

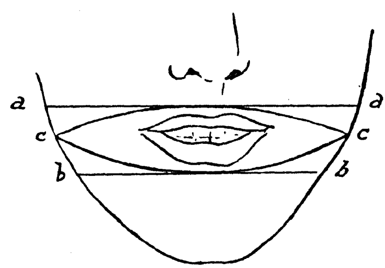


Fig. 37—Weber's touch illusion. From James, *Principles of Psychology,* Holt, publishers.

The famous illusion of Aristotle (Fig. 36) illustrates the erroneous way in which we perceive objects tactually. Cross the fingers as indicated and place a pencil or a marble between them, and you react as in the ordinary case; but when the nodal points are touched, you misperceive them as two things.

Another type of touch illusion is exemplified by the observation made by the eminent physiologist Weber, that if a pair of compasses are drawn across the face, as in describing lines AA, BB in

Fig. 37, the points above and below the mouth appear to diverge and then come together again as though they really described lines CC.

Some Experimental Studies of Perception

PERCEIVING DIFFERENCES.—The first and some of the best experimental studies in human psychology belong in the domain of primary perceptual or discriminative interactions. As early as 1834 Weber, the German physiologist whom we have already mentioned, performed some experiments on the acuity of discrimination. He was occupied with the question: "How small a difference can we distinguish between stimulus objects?" Working with weights, visual distances, and sounds, he discerned that the discrimination could be stated as a ratio of the differences irrespective of the actual magnitude of the stimulus object. For example, the lowest difference that could be discriminated between weights was 1/40; between lines of different length, 1/100; and sound, 1/160. To illustrate, when you start with weights of 50, 100, 200, and 300 grams you must add 1¼, 2½, 5, and 7½ grams respectively to be able to discern the difference.

About thirty years later Fechner mathematically elaborated the experiment and developed a definite formula to express the principle. This he called Weber's Law. In modern form[3] this formula can be written as follows:

$$R \longleftrightarrow C \log S$$

where R is the perceptual response, C the constant ratio for each different kind of interaction, and log S the logarithm of the stimulus function.

Since Fechner's time a great deal of work has been done on such discriminations by means of various techniques called psychophysical methods. In general the Weber-Fechner law holds within certain limits, namely, when the magnitudes are neither too large nor too small. In the appended table are listed some of the values quoted for the ratio constant.

[3] Since Fechner thought in terms of a relationship between psychic and physical phenomena his formula was $S = C \log R$, where S is the sensation or mental state, C the ratio constant, and log R the logarithm of the stimulus (Reiz).

Table of Ratio Constants

Kind of Stimuli	*Ratio*
Visual	1/100
Weights	1/20-1/100
Pressure	1/10-1/30
Auditory	1/5-1/8
Temperature	1/3-1/4
Olfactory	1/3-1/4
Gustatory	1/3-1/4

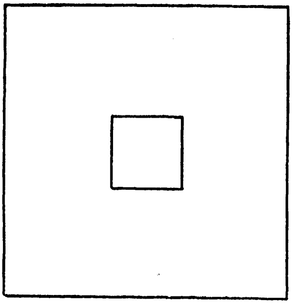
There is little uniformity in the ratios as obtained by different experimenters, even for the same type of stimulus. The figures vary for different subjects and for different techniques. As we have already seen, the kind of discrimination one can make depends also upon one's fatigue, health, attention, and interest.

SPATIAL PERCEPTION.—Stratton[4] designed a set of lenses that inverted the visual field for right-left and up-down relations and wore them for a week, except at night when he was blindfolded. During the first part of the experiment all his spatial perceptions were naturally confused and interfered with so that he had great difficulty in moving among things and in reaching for objects. Gradually adjustments were made; so that before the week was over he could respond to spatial conditions in quite normal fashion. This experiment demonstrates in an excellent way the building up of the spatial meaning of things, their location and arrangement, as well as the process of ecological discovery.

STIMULUS OBJECT AND SETTING.—The Gestalt psychologists especially have recently developed a large number of experiments that admirably illustrate the relations of stimulus objects to their settings. For example it has been shown that in such objects as in Figs. 38 and 39 you inevitably perceive the small figures set in the larger ones as a background. Again, in Fig. 40 you perceive the outer square as a setting for the two internal ones as a stimulus object. However, when the proportions of the distance between the squares are properly arranged one can either see any of the figures as set in the general background of the page, or as a series of objects and settings.

MOVEMENT.—Wertheimer performed a very interesting experiment on the illusion of motion. He arranged two parallel slits in

[4] See Selected References.



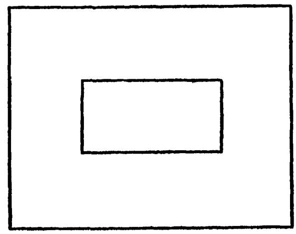
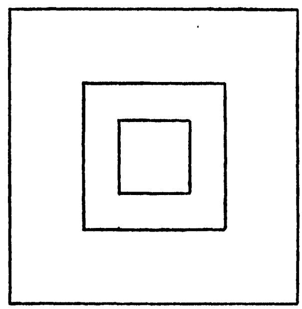


Fig. 38 (Left Above)—Small square object in square setting, or large square object set in page?

Fig. 39 (Right Above)—Picture frame or picture in frame?

Fig. 40 (Right)—Which is figure and which is ground?



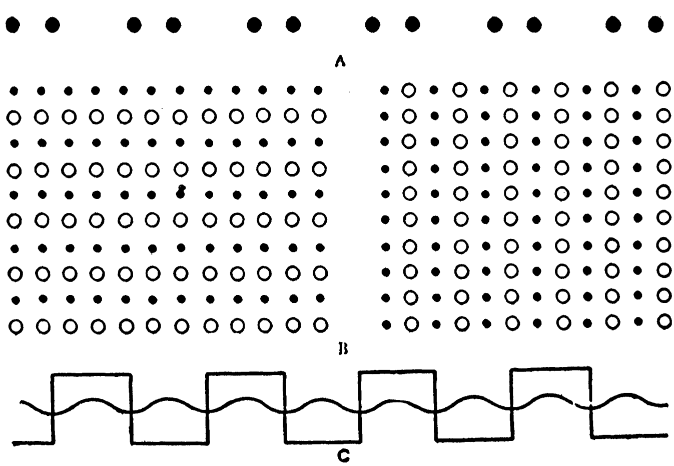


Fig. 41—Gestalt patterns. From Woodworth, *Psychology,* Holt, publishers, after Wertheimer.

a screen and illuminated first one and then the other with varying intervals. Now he found that a certain interval results in seeing not two parallel lines of light but a single line moving between the two slits. Shorter intervals do show two stationary parallel light slits while longer ones show first one illuminated slit, then another. This Wertheimer called the phi-phenomenon.

Pattern Effect in Perception.—The Gestalt psychologists have done fine work in showing that perception consists of responses to actual objects. In this connection they have pointed out what the pattern conditions are that favor seeing dots or lines as one or several objects. First there is proximity or distribution. The dots in Fig. 41a are most easily seen as pairs. Second, similarity. In many cases at least similar things can be more easily seen as objects than mixed things. This is illustrated in Fig. 41b. This result of course holds only for the examples. We have already seen in our Last Judgment illustration that the differences in things favor perception. The third condition is continuity. This is illustrated by Fig. 41c. Then there is inclusiveness which really means that objects have a certain autonomy and differentiable unity.

It must be added that the Gestalt psychologists as mentalists do not interpret their experiments as the interaction of the organism with things, but there is no question that another interpretation than their own is possible.

CHAPTER XI

IMPLICIT INTERACTIONS

When our loved ones are absent we can image them or in more poetical terms "see them in our mind's eye." When we are interested in or charmed by events of some time ago, we are able to muse and reflect upon them. Events that have never happened we can speculate upon, while impending or desired happenings we plan for and anticipate. How important these implicit actions are is plain when we note that they are the stuff of which dreams are made, and further that they constitute the basis for imagining, thinking, judging, and reasoning. What then is the principle of implicit behavior? It is that the organism responds to things when they are not present.

Implicit Behavior Requires Substitute Stimuli

How can psychological organisms interact with things which are not present? Do implicit responses therefore have no stimuli? Not at all. There is no exception to the scientific principle that every event consists of the interaction of at least two things. What happens therefore is that implicit responses are elicited by substitute stimulus functions. When I react implicitly to some object, I am stimulated to do so by proxy. The following lines from Shakespeare describe the process perfectly:

> "My wind, cooling my broth
> Would blow me to an ague, when I thought
> What harm a wind too great might do at sea.
> I should not see the sandy hour-glass run,
> But I should think of shallows and of flats
> And see my wealthy Andrew dock'd in sand,
> Vailing her high top lower than her ribs,
> To kiss her burial. Should I go to church
> And see me the holy edifice of stone

And not bethink me straight of dangerous rocks,
Which touching but my gentle vessel's side
Would scatter all her spices on the stream,
Enrobe the roaring waters with my silks."

While the interaction with an object that is completely absent exemplifies the essential character of implicit behavior, it is the extreme case. In the above illustration all the implicit responses are elicited by entirely different objects than the ones to which the adjustments are made. It often happens, however, that a substitute stimulus for responding to some object may be located in the object itself. Thus the person before me stimulates me to react to him as he appeared yesterday. Though he does not even see me or know that I am present, the sight of him arouses me to anger because I can still hear the insulting remark he made about me the day before.

All Implicit Behavior Originates in Direct Contact with Things

Originality is always a prized quality. We all acclaim the creative artist. And yet we cannot suppose that novelists, for instance, make their characters out of nothing. What we admire in an artist are the measured additions he makes to his living models to give them their literary quality. The charm of a Rosalind, the villany of an Iago, represent selections and coordinations of valued or despised traits. The same thing is true of situations. What the genius of a Verne can conjure up are combined and exaggerated features of the world that we all know in other connections. How else could we understand or appreciate that of which he writes? There may be more things in heaven and earth than are dreamt of in our philosophy, but there cannot be anything more in our philosophy than we have met with in our reactional biographies.

It follows that our most subtle and intricate implicit behavior is derived from actual contacts with things. Popularly expressed, we can never create anything absolutely new. Inventions are built upon materials and principles which have been known before. Mermaids are nothing but parts of women and fishes conjoined. The most fantastic imagination can only operate within the limits set by actual experience.

These limits, of course, have a wide range. When the scientist speculates upon cosmic distance measurable in terms of thousands of light years, we can hardly speak of having direct contacts with such phenomena. But even here it is easy to see that we have merely an elaboration of simple spatial phenomena, which, however far transcended, still form the concrete basis for astronomical thought.

Subtlety and Vividness of Implicit Behavior

Some implicit responses are extremely subtle in their operation. This is only to be expected, since implicit conduct may be far removed from the objects with which the person is interacting. We appreciate its subtlety when a great deal depends upon it. What is the enemy intending to do? It were better if he struck out and did his worst. Then there would not be the uncertainty and uneasiness of awaiting a possible doom.

When implicit interactions are subtle they are very difficult to observe. If we know what the substitute stimulus is for a person's response, we may appreciate fully what he is thinking of, but if not, we can only conjecture what he is reflecting or musing upon. Only when we know a man thoroughly, are acquainted with his reactional biography and behavior equipment, can we know the nature of his implicit action.

Howsoever subtle implicit interactions may be, they still may be extremely vivid. In contemplation or reminiscence we sometimes become decidedly wrought up and excited about some wrong that has been done to us a long time ago.

Independent and Subordinate Implicit Behavior

Implicit behavior may or may not be connected with other actions. When independent, implicit responses need not be concerned with any form of overt or effective behavior. On the other hand, the person sometimes responds implicitly to things as a form of psychological adjustment preliminary to some other kind of action.

Let us consider first the independent type of implicit response. Dreaming, musing, and reminiscing are all names for implicit behavior which is entirely independent of any effective adjustments. Such activities are indulged in for their own sake or for what

pleasure one derives from acting in this way, but they need not lead to any practical consequences.

Not that they are never connected with effective action. We cannot ignore the influence that dreams have upon the realization of our ambitions. Was this not Brutus' justification for homicide? For fear that Caesar's ambitious daydreams might lead to the seizure of an imperial crown, Brutus slew him.

Implicit action subordinate to effective conduct is of another sort altogether. Consider the work of an architect. Before he actually draws a plan he must respond implicitly to the wants of his clients, the cost of the building, its architectural character, and its fitness for the place in which it is to be erected. These planning activities we may regard as directly harnessed to other kinds of behavior. Similarly, the planning of an attack by a general must be regarded as auxiliary to its execution. Such implicit conduct must be checked on the basis of the conditions within the enemy's line and the possibilities involved in the operation of the general's own military machine.

How much of such checking is required in any particular case depends upon how necessary the preliminary implicit action is for carrying out some concrete enterprise. Psychopathologists have recently laid great emphasis upon a type of abnormal behavior which consists precisely of indulging in unchecked implicit action. They have given the name autistic thinking to activities which disregard altogether the actual nature of one's surroundings. Autistic thinkers are said to live in a world apart, a world of dreams where everything is molded to their heart's desire irrespective of the actual sweat and grime of the everyday world. To live in a fool's paradise is not the worst result of autistic thinking. Some abnormal dreamers reconstruct their surroundings so that everyone is hostile to them, persecutes them, or even plots their destruction.

What Kind of Actions Can be Implicitly Performed?

Psychologists have always stressed implicit action of the knowledge type, implying that we can only have substitute stimuli for things seen, heard, or otherwise perceived. This is not the fact. Practically every kind of interaction can occur through the intermediation of substitute stimuli. For example, they can evoke profound feeling responses. Such depressions and exaltations are in all respects duplications of actions performed first in the presence

of their adjustment stimulus objects. "X" is informed of some accident; he blanches, gesticulates, and sighs, suffering the same torments as though he were actually witnessing the event.

This is not all. When the substitute stimuli for implicit conduct are verbal descriptions, the intensity of our behavior configuration depends upon how vividly the speaker portrays the unfortunate circumstances to which our implicit response is made. Thus the skilful story teller can arouse his auditors to the highest pitch of feelings, or cast them down to the lowest depth of despair at the hapless fate of the heroine. When we inspect the feeling series of implicit interactions we find that all kinds of behavior configurations are involved.

Revived Interactions.—A young interne undergoes a dramatic experience. The attending surgeon is called away and the youthful physician must finish the operation himself. In what a tremendous situation he finds himself! For a moment he is quite overcome; he cannot conceal his excitement. His hands tremble, but only for a moment. He pulls himself together and performs a skilful and rapid operation. For many hours afterwards he is beside himself. Speak to him, he does not answer. He is intensely preoccupied; doing what? Obviously living over the experience in the amphitheatre. He is repeating over and over again his surgical triumph. You can see it in the motions of his hands, in the intensity of his face. In this kind of situation no definite substitute stimulus is required. Under ordinary circumstances this reliving of an experience occurs only when the person has recently gone through it. After a lapse of time we should not expect so intense an activity and one in which the person closely approximates the original behavior. In time the individual may only speak frequently of the original event.

There are, however, those persons who live over so vividly their striking experiences that they constantly resurrect whole scenes. A case of this sort we find in Janet's classic description[1] of the abnormal Irene.

This unfortunate young girl was the sole attendant upon her tubercular mother's last illness. The two women lived in an attic under the most trying circumstances. For sixty days and nights Irene nursed her mother while she earned a few pennies at sewing

[1] The Major Symptoms of Hysteria, (2), 1920, p. 37.

to ward off starvation. After her mother's death Irene tried to restore her to life and in her attempt to place the corpse in an upright position it fell to the floor, necessitating a great strain on the daughter's part to lift it into bed again. For some time afterwards Irene would reenact with consummate skill and scrupulous detail the whole scene of her mother's death. In doing so she repeated implicitly every possible form of effective behavior, feelings, verbal responses, and hallucinations.

Continuative Interactions.—An extremely interesting form of implicit behavior is that in which the response continues after the original stimulus and occasion have gone. In the following example the substitute stimulus is located in the needs and distress of the actor and the response is verbal in configuration. When Titus Andronicus is overwhelmed by the judgment pronounced by the tribunes upon his sons, he continues to plead for their lives even after the tribunes have left the scene to carry out the execution of their sentence. . . . .

"My gracious lord, no tribune hears you speak," says Lucius, and Titus answers,

> "Why 'tis no matter, man, if they did hear
> They would not mark me; or if they did mark
> They would not pity me, yet plead I must
> And bootless unto them."

Incipient Interactions.—Have you ever attempted to tell someone the name or telephone number of a third party and found yourself unable to do so? How did you finally accomplish your purpose? You began to pronounce the name or number and finally you found you could. Until you were able to do so your more or less futile attempts constituted incipient implicit responses. Almost every one at some time or other finds himself unable to spell a word. Success is often finally assured by starting to write the word. Here is a graphic form of incipient response exactly like the vocal type above. Both of these incipient forms of implicit behavior reach back directly of course to previous performances.

Anticipative Interactions.—By this term we label a type of implicit behavior which is midway between a direct reperformance and the incipient type. Perform this experiment. Hold up to the full view of some selected victim a file and a knife and then

pretend to draw the file across the edge of the knife. If you have selected your victim properly, he will report a decidedly disagreeable response with much shuddering, some trembling, and even some gnashing of teeth. Although the reaction is reminiscent of a past filing and rasping event, it is now anticipative by means of the substitute stimulus threatening to subject the individual to another such experience.

VESTIGIAL INTERACTIONS.—We come finally to those reactions which, as we have already indicated, have been celebrated in the history of psychology as the exclusive form of implicit behavior. These responses are known as various forms of imagery.

(a) *Positive After-Images.*—Stimulate yourself by looking at an electric light for just a moment; then turn away and you still see the light for a brief period. We may regard this as genuine implicit behavior although we do not have a substitute stimulus. The visual response merely continues after the stimulus is removed. The basis for this type of phenomenon is undoubtedly physiological in character.

(b) *Negative After-Images.*—Make a cross out of a vertical piece of black paper and a horizontal arm of white paper. Fixate this for fifteen or twenty seconds. Then look at the gray wall. You will find a cross projected there with a white vertical and a black horizontal strip. Similarly, if the original cross is made of two different colored strips the projected cross consists of complementary colors. These negative after-image phenomena are also physiological in nature. Negative after-imagery is essentially like color adaptation. If you stay long enough in a room lighted by a red bulb the red cast of things will finally disappear, and then when you enter a white lighted room everything in it will take on a bluish-green tinge.

(c) *Eidetic Imagery.*—A number of German psychologists have recently made searching investigations of implicit responses which occur as soon as the original stimuli are removed. The eidetic individual (person who performs eidetic reactions) is asked to look at an object; then when he closes his eyes or turns them to the wall he can still "see" the object in all its vividness and clarity. The substitute stimuli here are closely connected with the original stimulus object. The eidetic individual or some other person may sug-

gest that the imagery action be performed. The subject too can vary the performance so that he will "see" the object with variation in color, size, mode, and arrangement. The psychologists who have made special studies of these implicit activities believe that while some adults perform them as well as children they are primarily phenomena of early child life.

(d) *Perseveration Imagery.*—It is a familiar fact that after listening to a striking musical composition one may be haunted by a melody for many days after the original hearing. As it is put in colloquial expression, tunes run through one's head. The same sort of experience is the constant re-viewing of striking and im-

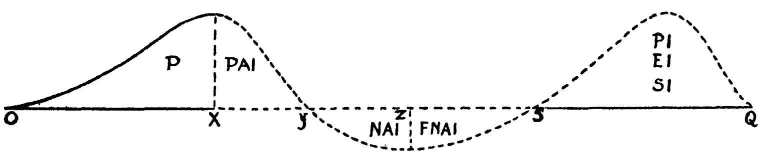


Fig. 42—Diagram to show relations between different forms of stimuli and responses. Description in Text.

posing scenes. To a considerable extent these implicit seeing and hearing reactions themselves serve as substitute stimuli for their repeated reperformance.

(e) *Survival Imagery.*—These phenomena constitute the vestigial remains of the precurrent perceptual reaction systems of response patterns. We see, hear, smell and taste things despite the fact that these things are not before us now and have not been for some time. We may regard these responses as survivals of former actions which are now elicited by substitute stimulation, especially of the verbal type.

Relation Between Vestigial Responses.—In Fig. 42 we present a diagram[2] which indicates a possible relationship between the different kinds of vestigial implicit responses. The straight line OQ represents the stimulus conditions of such interactions, while the waved line stands for the type of response. The heavy segment OX indicates a definite perceptual interaction. The person is stimulated by the actual object—namely, a cross with a red vertical and a blue horizontal arm. The corresponding perceptual

[2] This diagram was suggested by a figure in Woodworth's Psychology, p. 356.

reaction (P) is represented by waved line segment OX. The dotted line XS represents the period when the person is out of contact with (not looking at) the cross, though the response continues as implicit behavior as follows. From X to Y occurs the positive after-image form of implicit response (UAI); from Y to Z is the negative after-image (NAI); from Z to S the fading negative after-image (FNAI); and finally from S to Q the individual is stimulated again by an external object, but now it is a substitute stimulus, perhaps a verbal suggestion. The waved line SQ stands for either a perseverative image (PI), an eidetic image (EI), or a survival image, sometimes called a memory image (SI).

Conceiving

The process of conceiving admirably exemplifies the operation and value of implicit behavior in human life. All the work of thinking, planning, inventing, and creating things depends upon our ability implicitly to handle things and their qualities as well as events. We may generalize and say that conceptual behavior is essential for distinctively human adaptations to things, and that conceiving plays an enormous part in making possible man's existence upon a higher level than the crude overt interactions with things. It must be added of course that the effectiveness of our conceptions corresponds directly to the degree in which they have been derived from overt interactions.

To illustrate the conceptual interaction with things we may consider three forms of such implicit behavior.

Abstracting Qualities and Relations.—An example of conceptual abstraction is afforded us in the reaction to the three classical orders of Greek architecture. Here we select out the likenesses and differences by analyzing or implicitly dissecting the objects actually before us or as imaged. We abstract from each its particular quality or form, such as type of column fluting, shape and design of capitals, structural simplicity or complexity, etc.

Present the following stimuli to someone and have him fill out the blanks.

Kant is to Germany as Hume is to ——.
Shelley is to England as Heine is to ——.
Napoleon is to France as —— is to England.
Franklin is to America as —— is to France.

This exercise illustrates the abstraction of some relationship out of the situation.

Elementary geometric concepts have been developed by abstraction from a long series of overt contacts with square, spherical, and conic objects. Out of such concepts has been built up the science of geometry. Such processes of abstraction as these lie at the basis of all our sciences.

Generalizing.—Conceptions are likewise based upon generalizing things or events. When we land in Bremen we see for the first time a man's hat with the bow in the back instead of on the side. It seems very peculiar until we see another and still another. By implicitly putting the various German hats together and comparing them with French or American ones we generalize and grasp the idea or conception that the German custom is to put the bow in the back.

Constructive Organization of Previous Experiences.—Ask someone what his idea or conception of the Inquisition is. If you observe carefully his reaction, you will see that his conceptual behavior here consists of implicitly organizing his past contacts with this thing. He will put together what he has heard and read about the religious, geographical, and political features of the inquisition until he has an intellectual product.

The stuff of all knowledge and science consists of just such constructive handling of things. Sometimes our scientific conceptions are very like natural things, such as our geometrical concepts. But in other cases they have no visible likeness to real objects. How far a cry it is from the paper upon which these words are printed to the protons and electrons of which physics tells us these pages are constituted. Though there is no analogy here, there must be a concrete abstraction, or otherwise there would be no possibility of controlling or understanding things by means of such conceptions.

For the most part the substitute stimuli for conceptual forms of implicit behavior are symbols. Think only of the place of symbols in the mathematical and physical sciences. In general, written verbal symbols play a large part in building up and performing scientific conceptual reactions. In the simpler situations of everyday life speech forms serve the purpose of substitute stimulation.

Conceiving and Defining Reactions.—The process of conceiving can be well studied when it is connected with defining behavior, which is its verbal counterpart. It is a well known fact that children often define things on the basis of what can be done with them. A table is to put something on, spectacles to look through, a knife to cut with, etc. Such definitions indicate how children conceive of objects. Children also conceive of things analogically and comparatively. A child of two calls a violin a horn because his only previous acquaintance with musical instruments was with his father's cornet.

Dreaming While Asleep

The phenomena of dreams, which have always fascinated mankind, have, under the influence of Freud and his followers, captured a great deal of scientific attention. That dreams are implicit action is clear, but what gives them their particular character? The question why we dream can be answered by saying that since we are not working or are not in the presence of the objects and situations of our every day existence we respond implicitly. But what makes our dreams have the particular organization that they have? Here lies the significance of Freud's ideas. Dreams, Freud says, are wish fulfilments. In dreams we obtain those things which we do not and cannot have when awake. But unfortunately he adds that wish fulfilments are mostly sexual in character.

The refutation of Freud's theory can be traced out in his very argument for it. Point out to him that children dream who are too young to have any sex desires in the ordinary sense. He answers that sex is a phenomenon that reaches far beyond ordinary sex phenomena. If he must redefine sex in this way we may regard his theory as outside the bounds of actual facts. Again, when we show that even the dreams of adults have no resemblance to sex phenomena, he asserts that dreams are symbolic and that one must look for hidden meanings. This kind of special pleading also weakens rather than supports the Freudian theory.

Dreams, we must insist, are implicit activities which fit into every conceivable phase of our lives. These activities represent the person as acting in every possible situation when not in direct contact with the objects and conditions of the ordinary workaday world. Dreams are the evidences that persons are never inactive,

even when asleep. For this reason when the individual is asleep or otherwise not carrying on his normal enterprises, he is free to respond implicitly in the most phantastic manner. It is this fact that accounts for the great variety and peculiar combinations of dream behavior.

Wish-fulfilling Dreams.—Are there wish-fulfilling dreams? No doubt. Things desired or wished for that are unattainable in waking life are easily obtained in our dreams. The prizes that we cannot win in actual competition are ours when we are free to annex them. Again, are there sexual wish-fulfilling dreams? Undoubtedly. Many of the dreams of the sexually hungry are satisfying in that respect, just as the starving explorer gorges himself when his hunger pangs are allayed enough to let him sleep. The rule works in these dreams as in all others—namely, that they are continuous with waking activities.

Review Dreams.—In just as many of our dreams we merely live over the day's activities. We carry on our business, work upon our problems, meet our friends just as we have ceased to do overtly before we went to sleep. Perhaps here we have a more obvious transition between waking and sleeping behavior conditions, but it is only different in degree.

Anticipatory Dreams.—Without in the least desiring or dreading certain events, we often in our dreams anticipate future happenings. A prophet one may be in one's dreams though one cannot be such otherwise. Not that the anticipatory dream always anticipates events. It does not. But the fact that it might do so gives a distinct tang to these dreams.

Compensatory and Escape Dreams.—Poverty is hard to bear. We can compensate for this condition by dreaming that we are wealthy. Many undesirable conditions are thus overbalanced by the pleasant and happy circumstances of our implicit construction when the bars of concrete reality can be easily hurdled. With a little practice we can escape in our dreams from the dangers and disasters that surround us during our waking moments.

Phantastic Dreams.—To the foregoing types, we must add all those peculiar and senseless dreams in which we mix up in wild array all sorts of impossible and grotesque situations. In such dreams one sees and participates in events that defy description.

Although here the connection between the implicit activity of the sleeping state is hard to connect up with the affairs of waking life, it is more than reminiscent of the strange and fascinating adventures of which one has sometimes read.

Day Dreaming

Day dreaming differs from night dreaming primarily because of the different conditions involved. Like the night dreamer the day dreamer is detached from the problems and situations of ordinary human living, but not because nature and the habits of man have contrived to divide off night from day. The day dream takes place merely while the dreamer is relaxed and for the moment is enjoying a lull in the affairs of life.

For this reason day dreams are much more of a piece with one's daily activities. They are therefore on the whole not so phantastic as night dreams. In day dreaming our castles in Spain have their foundations laid in our usual experiences. The golden bridges that we construct to the future are meant to extend our present circumstances. Thus day dreams tend much more than night dreams to be activities of wish-fulfilment. A large amount of day dreaming, however, consists of merely enjoying situations that are not actually available. In this way the person can play the part of a hero, a man of the world, a successful personality in a way that does not happen in his real life.

Many day dreams, too, are not forward looking at all, or even the enjoyment of present beatitudes, but merely living over in fancy past events. This type of dreaming is conventionally called revery. It must not be supposed, however, that only pleasant experiences are thus lived over; in this relaxed retrospective action one lives through all sorts of bitter disappointments and harrowing experiences.

One sharply contrasting quality of day dreams must be mentioned. Just because these activities go on when we are awake and are definitely continuous with every day activities they are sometimes liable to be mixed up with actual life situations. It is a serious pathological condition to confuse one's dreams with reality. If we act as though what we dream were really true, we are very liable to interfere with our own welfare and that of others. Such confusion of dreams and reality spells madness. We have already become acquainted with those individuals called autistic thinkers,

who, because they cannot or will not withstand the shocks of daily life, withdraw from the world of fact and live in the domain of their dreams. They are more harshly said to be persons who live in a world of illusion and false belief.

Individual Differences in Implicit Behavior

The universal and absolute law of individual differences which we considered in Chap. 2, finds one of its best illustrations in the field of implicit conduct. The reason for this lies probably in the fact that implicit reactions can be performed without direct contact with their respective adjustment objects. Consequently, we can differ much more in respect to this kind of action than any other. Thus in dreaming, revery, thinking, and imagining, we vary more than in our perceiving reactions, since in the latter case we are interacting with adjustment objects directly. We may discuss the problem of the present section by examining three fertile fields of individual differences in implicit behavior—namely, visual imagery, synaesthesia, and number forms.

Visual Imagery.—Galton,[3] upon becoming interested in the problem of individual differences, attempted to collect data on this subject by sending out a questionnaire, from which we quote the following:

"Think of some definite object—suppose it is your breakfast table as you sat down to it this morning—and consider carefully the picture that arises before your mind's eye." He then goes on to ask whether the image is dim or clear and whether its brightness compares to that of the actual scene. Also he wished to know whether the objects are or are not well defined. In particular he wanted to know whether the colors of the objects (china, toast, etc.) were quite distinct and natural.

The first results proved that his informers differed enormously. Some of them, and especially men of science, claimed that "mental imagery" was unknown to them. One of his correspondents wrote as follows:

"These questions presuppose assent to some sort of a proposition regarding the 'mind's eye,' and the 'images' which it sees. . . . . This points to some initial fallacy. . . . . It is only by a figure of speech that I can describe my recollection of a scene as

[3] Inquiries into Human Faculty and its Development, Everyman Edition.

a 'mental image' which I can 'see' with my 'mind's eye.' . . . . I do not see it . . . . any more than a man sees the thousand lines of Sophocles which under due pressure he is ready to repeat."

At the other end of the scale are those who report that the mental image appears to correspond in all respects to reality. It is as clear as the actual scene. One correspondent wrote, "I can see my breakfast table or any equally familiar thing with my mind's eye quite as well in all particulars as I can do if the reality is before me." This same study resulted in the information that

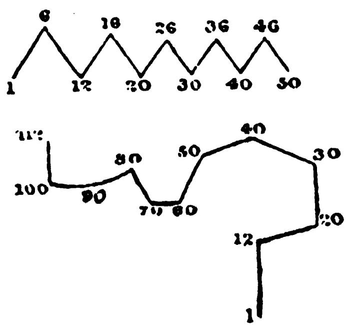


Fig. 43—Illustrating different types of comparatively simple number forms. From Galton, *Inquiries into Human Faculty,* Dutton, publishers.

these individual differences are probably a matter of practice, although Galton thought otherwise.

Synaesthesia.—Another distinct form of individual difference is illustrated by the fact that persons combine their imagery in various ways. They hear sounds as if colored; they visualize numbers as tinted. One of Galton's correspondents wrote that numbers appeared to him colored as follows: one—black, two—yellow, three—pale brick red, four—brown, five—blackish gray, six—reddish brown, seven—green, eight—bluish, nine—reddish brown something like six.

Similar synaesthesias consist of an association of sounds with colors. Some people associate only vowels with colors while others connect consonants with colors also. Some of those who associate colors with other things in their implicit behavior insist upon specifying the particular color with which each sound or number is connected.

Number Forms.—A most peculiar type of individual difference is the visualization of numbers according to some pattern. Various persons report that they "see" numbers arranged in some particular order or design. These individuals not only image numbers in this way, but they also use the number arrangement to carry out various arithmetical problems. In Fig. 43 are illustrated some of these designs which Galton obtained from various persons.

CHAPTER XII

KNOWLEDGE AND OTHER INTELLECTUAL INTERACTIONS

Knowing is Orientation Behavior

Popular expression has erroneously divided off knowledge from action. Before we study psychology we think of behavior as exclusively effective—namely, interactions in which we manipulate something, pick up an object, tear it, or otherwise bring about some definite effect. This is a mistake. Much human behavior consists of action which results in no change in the things with which the person interacts. He merely orients himself to them. Were our reactions all of the effective type we should have to regard ourselves as psychologically far simpler than we actually are. In the infrahuman world, of course, activity is mostly manipulative.

The term orientation refers to several different kinds of responses or behavior patterns. We may orient ourselves by assuming an intellectual attitude, or developing an idea about something. To know Fascism is to be able to place it as a political theory or practice, and perhaps be for or against it. Perhaps the simplest form of orientation is to know, when something is mentioned, what it is that is spoken of. More elaborate responses are to appreciate what it is like, and to be able to predict what it will do under certain circumstances. To know hydrochloric acid is to be aware of what it is composed, how it can be made, and what effect it will have upon a piece of silver dropped into it. Other orientational responses consist of being able to understand and speak of its origin, its implications, its significance, and possibilities. All these behavior patterns are intellectual in character rather than effective or manipulative.

While knowledge reactions as such are different from effective responses, they are obviously not unrelated to them. Many of our orientation reactions are directly derived from manipulative be-

havior. Is this fluid acid or alkaline? It is only by testing it with litmus paper that I know. Without putting the paper into the fluid I cannot be oriented. On the other hand, knowledge operates in the service of manipulative behavior. It is to be hoped that whenever we manipulate our carburetor we do so because we know what adjustment is needed and just how to make it.

Meaning and Knowing

Orientation responses differ in the degree of connection with effective behavior. They can thus be divided into two large classes called meaning and knowing.

Meanings are Determinative.—When I am trying to move a heavy stone I react to a strong stick by seeing it as a lever. My orientation response determines what I shall do with the stick, how I shall manipulate it. To say that the stick means something to me is to say that my reaction to it determines me to use it in a particular way.

But meanings do not always precipitate manipulative acts. They may determine me merely to have a better idea concerning something. The engine rumble of which I have just become aware in my recently purchased used-car stimulates me to think of a loose bearing, and immediately I know why the dealer was so eager to sell it to me.

Meanings therefore consist of precurrent reaction systems which operate to determine what the rest of a response pattern will be like. Suppose the teacher holds up before the pupil a card upon which is printed the word "house." If the word stimulates an orientation response, in other words if he appreciates what it means, that response determines him to answer "house." Here the meaning reaction is precurrent to a final verbal response.

A somewhat different type of meaning behavior segment is that in which the "hefting" of a coin stimulates us to realize whether it is counterfeit or genuine.

Knowing is Purely Orientative.—By contrast, knowing behavior is purely orientative; that is, it is independent of any further action. When I look at a painting and appreciate at once that it is either a work of Botticelli or his school, the behavior segment is complete. The psychological adjustment consists entirely of my cognitive response. This means that the orientational act is the

final reaction system. It follows, of course, the attentional and perceptual reaction systems. The whole response pattern is called cognitive, since we have learned (Chap. 2) that the character of a response pattern is determined by its final reaction system. Although knowing behavior segments may be connected with other kinds of actions, as when my knowledge that X has a rare book for sale may lead to my buying it, the knowing action as such is purely orientative. Knowing, as over against meaning behavior, therefore, consists of complete behavior segments rather than just reaction systems. Or we might put it this way: knowing is always a final response, while meaning is a precurrent one.

Comparison of Meaning and Perceiving Reaction Systems

If, like the perceptual response, it is the essential character of a meaning reaction system to anticipate and determine some final reaction, the question arises at once how meanings compare with perceptions.

Perceiving is but an elementary form of meaning behavior. We have learned that when we perform perceiving responses we realize the nature of the object to which we are responding. We perceive the round yellow sphere of an orange as an edible thing. This preliminary act determines what the rest of the response shall be. In this sense perceiving is a simple orientation act.

But notice that whereas in performing perceptual activities the person always interacts with the qualities of an object immediately present, this is not the case in meaning behavior. In the latter he responds to qualities attributed to the object. After perceiving the orange, that is, identifying it, I become oriented to the fact that this year it is an expensive or rare fruit. In other words, while the perceptual reaction system is at most partly implicit, meaning reaction systems are entirely implicit. As our illustration indicates, meaning responses operate in addition to perceptual reactions.

In the case of perceptual reactions the determinative character of the action depends much more upon the stimulus object than is true in meaning. What I do after perceiving an object depends a great deal upon what it actually is. Not so in the case of elaborate meaning behavior, which depends more upon the conditions of the determined final response. Of the cigars displayed, brand A instead of B means my cigars, not because they are of a certain

shape, size, or smoking quality, but because they are the ones that I can afford to buy.

Meanings Comprise a Variety of Reaction Systems

Functionally, meaning acts consist of implicit determiners of final reaction systems. As individual activities, however, these meaning acts differ widely as specific behavior configurations. In terms of action, what things mean to us is what they make us do. Some of these different action configurations and the meanings they represent are indicated in the following paragraphs.

Manipulative Meanings.—How much is a pinch of salt? The old-fashioned cook must constantly face the question how much of a certain ingredient is sufficient for her purpose. So much flour means the proper amount, but to know how much, she must handle it. Manipulating the material stimulates the orientation which leads to successful culinary performance.

Mill tells us of a cloth manufacturer who imported an expert dyer to teach his workmen how to produce fine colors. It turned out, however, that the experiment was a failure. The dyer in question knew just how much dye to put into the vat only by filling his hand. So much dye as measured by the grasping hand meant to him the right amount. Since such meaning reactions could only be acquired by long experience, the dyer was unable to teach anyone his skill.

Non-Performative Meanings.—This type of meaning is illustrated by our orange example. When I appreciate that this object before me is expensive my orientation act represents a purely ideational atitude, although my act determines that I shall not ask for or purchase it. In itself this meaning reaction consists of no visible movement or performance.

Affective Meanings.—Oftentimes what a situation means to us depends upon the feeling it arouses in us. To the person in whom a bullfight elicits disgust or horror it does not mean an interesting and desirable spectacle. But when we are thrilled by such an exhibition and admire the participants in the pageantry, our orientation is quite different and determines entirely different further responses.

The affective type of meaning response undoubtedly plays a large part in aesthetic judgments. The artistic appeal that a picture

or a building makes to us depends upon the kind of affective meaning reaction that it calls out. This idea has been elaborately developed by the German psychologist Lipps, in connection with his conception of empathy or Einfühlung. According to Lipps the appeal an object makes to us depends upon the feeling state it arouses. A short, stodgy tower calls out in us an unpleasant reaction, whereas a tall, slim tower arouses the opposite response. According to this theory the person, projecting into the stimulus object the kind of feeling it arouses, gives the object a high or low value as an art object. The feeling state, in other words, induces at once a particular kind of value judgment. What the object means or is worth is thus determined by a feeling response.

Verbal Meanings.—What is that? A asks this question of B when he sees an unfamiliar plant. But B himself knows very little about the plant. If he is able to say, "it is viburnum," both are satisfied that the plant means a great deal to them. It is probably true that verbal actions are among the most predominant of meaning behavior configurations. These verbal meaning responses need not be spoken out loud; they can determine further performances even when they are subvocal.

Knowledge Orientations Derived from Overt Interactions

Although each knowing action is developed from some contact of the person with an object or situation, some of these contacts are very remote. Naturally the most effective and significant knowledge is that derived from direct contact with things. For this reason educators emphasize first-hand information in teaching and learning. The aviator must go through his ground school training so he will really know an airplane. The student must actually dissect his animals and make his chemicals react in order to know biology or chemistry. Some medical schools insist that a year of interneship (actual contact with patients) must be had before granting the degree, Doctor of Medicine.

But this directly developed knowing is not always possible in such a complex civilization as ours. Besides, much of our knowledge is analogous. We know what papayas are, not because we have actually eaten them, but because they are like some other fruit with which we have had direct experience. Most of our knowledge, therefore, must be secondary in this sense and even

farther removed from direct interaction. Some things we know because they have left traces such as lakes made by glaciers. We know that migrations have taken place because immigrants have left descendents in the new geographical location.

Types of Knowledge Orientation

Cognizing.—The person searching for mushrooms must avoid picking any but edible ones. For this purpose he requires at least a minimum of orientational behavior. The individual can do no more perhaps than differentiate between edible and poisonous fungi. Such knowledge does not go much beyond perceptual responses despite the fact that the person is not in immediate contact with the qualities and properties of the mushroom with which he interacts.

From a functional standpoint cognition operates only as an orientational aid. It consists only of reactions to elementary properties of things. Our mushroom hunter may be totally ignorant of all botanical facts concerning mushrooms.

Recognizing.—The typical thing about recognition is that it occurs in dated situations. When I recognize a person I am oriented with respect to a previous behavior experience with that individual. In other words, I know that I have met him before.

As we should expect the recognitive orientation may be simple or quite elaborate. To know only that I have seen this object before is very little compared to knowing the exact circumstances under which the former experience occurred.

Appreciation.—Compare the orientation of the expert botanist with the mushroom hunter. Because the former has had so much more experience with fungi he can classify and define them in a way which is far beyond the powers of the latter. We may differentiate between these two forms of orientation by saying that the botanist not only knows, but also appreciates what a thing is. As a result he can evaluate it. How well he can do so depends upon the number of things and conditions with which he can connect it. In this sense botanists, too, differ in their knowledge. One may be much more oriented than the other.

The appreciation form of cognition is well illustrated by the diagnostic behavior of a physician. The doctor who can correlate such symptoms as temperature, proteid excretion, etc., with a par-

ticular kind of disease performs a higher form of knowing response than one who is unable to make such connections.

UNDERSTANDING.—To understand some thing or event is to be so well oriented with respect to it as to be able not only to evaluate it, but also to connect it with principles of development, operation, and future change.

When we are well oriented to a thing, we are able to prognosticate or predict what will happen to it under various given conditions. We are fairly sure to understand a person if we know what kind of treatment will please or displease him.

Adequate and Inadequate Knowledge

When is knowledge adequate? There are two answers. First, our knowledge is adequate if it enables us to handle things effectively. Adequate knowledge we may therefore define as orientational responses which conform closely to the actual qualities of things.

But this criterion will not apply when no sort of effective action depends upon our knowledge. In such situations the criterion may be (a) the person's own satisfaction with his orientational attitudes, (b) the conformity of his knowledge with the knowledge of people around him, and (c) the harmonious inclusion of some bit of knowledge in a larger knowledge system to which it pertains.

Knowledge and Information

Knowledge responses are individual adjustments to things, and despite the fact that they represent different degrees of contacts with objects they must be developed in the personal experiences of the individual.

By contrast with knowledge, information consists of orientational reactions which represent no first-hand interaction of a person with objects. Our information is based upon what we have read or been told. It may be correct or incorrect, and in this sense it is distinguished from genuine knowledge, which may be more or less efficient or adequate, but never entirely unrelated to things.

Psychological versus Social Knowledge

In our everyday speech the word knowledge refers to things rather than to activities in the strictly psychological sense. These

things we may call social or institutional knowledge, such as beliefs and opinions passed down from generation to generation. Every social group harbors among its cultural equipment a mass of traditional wisdom embodied in proverbs and maxims. It is not our concern whether such wisdom can pass the test of scientific accuracy.

The persons comprising every group know something of the history of the group or its heroes; they are acquainted with the ways of the animals and plants in their district and possess various ideas concerning neighboring groups of people. But, after all, such knowledge consists really of things and not actions. Social knowledge connects with psychological phenomena only as individuals speak of their traditions or accept them as true. Traditional wisdom serves as stimuli. But this social knowledge can also operate as responses. When we know that our own nation is the most superior and the most virtuous we are performing knowing reactions in the same manner as when we put on blue or gray clothing in answer to the demands of fashion.

Intellectual Reactions

Knowing behavior contrasts with direct performance. Orientational responses frequently replace effective adjustments. Now since knowing is more or less remote from overt performances there must be degrees of orientation. But our orientation goes even beyond the most remote knowing response. When we cannot know the nature of a thing we may have an opinion about it. If we are unable to count the people in a city we can guess the number. Opinions and guesses belong to the class of intellectual attitudes.

The various members of the intellectual group of reactions differ very widely. They all have one fundamental characteristic in common, however—namely, they are all implicit, because they are responses more or less widely removed from the adjustment stimulus objects. Our knowledge that water boils at 100°C is derived from perceptual contacts with water in its various states, whereas the belief that the universe is finite is far removed from any direct observation.

OPINION.—Which team will win the championship? The outcome of the present football season is a matter of the future and therefore is unavailable for our observation. Our orientation must therefore be incomplete. It is not, however, a mere matter of

guesswork. We do have information about the relative strength of the teams. Also we know something about the different coaches. But we cannot know which team may be crippled or what players disqualified, among other deciding factors of the final results. In such cases our orientation must perforce be a matter of opinion. It is easy to see that opinions are the raw materials of speculation.

Assumption or Hypothesis.—The anecdote is told about Alfred Harmsworth, who later as Lord Northcliffe became England's most famous journalist, that when he went to Nevens to apply for his first journalistic position he wore his high silk hat. Although English journalism was beginning to turn completely away from everything that the silk hat suggests, Northcliffe did not know it and accordingly he naturally assumed that that was the proper way to approach an editor. This anecdote suggests how the absence of knowledge that an established order is changing makes room for an assumption.

Our illustration is taken from everyday behavior. Activities similar in principle constitute very important features of all scientific investigation. The necessity to investigate phenomena which are not immediately available for complete knowledge stimulates the scientist to develop some hypothesis. Here the attitude is not casually suggested but necessarily indicated. Thus the intellectual response is very deliberately and definitely built up. Ever since the discovery of the cave drawings which were executed a long time before recorded history, scientists have had to hypothesize, in view of the artistic capacity these drawings reveal, that complex human mentality must have been developed in prehistoric times.

Guessing.—Assumptions incidentally developed in unimportant situations we call guessing. Some one raises the question as to the population of Arabia. We may have no facts whatever to go on, not even the suggestion afforded by general social circumstances as in the Northcliffe example. Yet we take some position. Such an attitude cannot be more than a guess. Guessing attitudes are the most indifferent and amateurish and thus farthest removed from consequential action.

Postulation.—Scientists constantly set up more or less arbitrary intellectual conditions for the purpose of building up scientific systems. Such responses we call postulation. The mentalistic psychologist deliberately assumes that psychological phenomena are

different from those of all the natural sciences and that they can still be studied scientifically. The behavioristic psychologist postulates the non-existence of such phenomena and assumes that the mind consists entirely of actions of the biological organism.

The subject of postulation has recently been studied in mathematics more than in any other field. Accordingly geometers now agree that there is no absolute form of geometry, but that there are as many geometries as one can build up on separate postulates. If you assume that the sum of the angles of a triangle equals two right angles you get Euclidean geometry; if less than two right angles, hyperbolic geometry; and if you postulate that it equals more, you have Riemannian geometry.

BELIEVING.—Belief reaction is primarily an acceptance of a proposition. This means that the response is an implicit one—namely, we respond to an absent object or situation. The substitute stimulus in this case is generally linguistic. We believe what we are told or what we read.

What then do we believe? Everything, unless there is some experience which interferes. For this reason psychologists of several decades ago used to say that we are born with an inclination to credulity. Those who have seen Paris do not believe the statement that New York is the most beautiful city in the world. A previous acceptance of a statement also interferes with a new intellectual orientation. The child being told that his own is the greatest nation, before he has any basis for not accepting the statement, thereafter is fortified against believing the contrary.

Whether or not we believe a statement depends also upon the authority of the teller. If we regard as authoritative the person who stimulates us to believe something we accept his suggestion, otherwise not. What we see in print we are for this reason prone to believe. The good concerning ourselves and the evil concerning others seem to have such weight and authority.

An interesting experiment in the field of belief was performed by Poffenberger[1] in connection with advertising materials. He presented a number of students with an advertisement and asked them whether or not they accepted the statement made. He discovered that a large percentage of the subjects did, although it turned out that they did not understand the claims made nor did they know them to be valid.

[1] The conditions of belief in advertising, *J. of App. Psych.*, 1923, 7, 1-9.

Disbelieving.—To disbelieve a proposition is to reject it. As a form of behavior, disbelieving then is the opposite of believing. Disbelieving is conditioned in several ways. First, the evidence is not sufficient to induce the acceptance of the proposition, or the person does not have enough confidence in the statement. Again, there may be facts to indicate that the proposition is not credible. A very interesting form of disbelieving is the intellectual reaction which is highly complicated by one's feelings. The following words from a letter of Heine illustrate the point. He writes to his friend, "although I have the most infallible, irrefutable proofs that she does not love me at all—yet my poor loving heart will still not be convinced." This is a case of disbelieving despite the ordinarily sufficient indications that conditions do not warrant such a reaction.

Doubting.—We are told that X is dead, but we saw him only yesterday in apparently perfect health. Here is typical doubting behavior. We are behavioristically hung up between accepting and rejecting the proposition and can do neither.

Intellectual Reactions Subject to Various Influences

Whether we believe that our own football team will win the game rather than the opponent is considerably conditioned by our own desires and hopes. In such a situation, of course, it is possible to isolate a number of facts, such as the previous winnings of the respective teams, the number of men disabled on each, and so forth, but as a matter of fact we are just as likely as not to select and weigh those factors which support our attitude rather than to have our attitude actually based upon the facts of the case. Psychologists point out that we often believe what we want to believe. Certainly beliefs are very vulnerable actions.

Believing as a reaction to probabilities is somewhat more subject to extraneous influences than are such orientations or attitudes as assumption and opinion. But these two, since they are activities representing a remote connection of the individual and the adjustment stimulus object, are subject to various forms of outside influence. Our opinions are very often influenced by tradition and hearsay as well as by our admiration for superiors and social preconceptions.

CHAPTER XIII

FEELING INTERACTIONS

Effective and Affective Responses

It is the end of the semester. Examinations are over. The grades are posted on the bulletin board of the lecture room. A group of students approach, each one eager to see the reward of his term's work. Let us watch them as they find their names on the long list. A's eyes droop. His face clouds; its customary brightness vanishes; his whole posture loses its buoyancy. The "F" he finds posted opposite his name casts him down.

But notice what happens to B. His eyes glisten while his face lights up. The increased elasticity of his step bespeaks the gayety with which he is suffused. The "A" which he has received elates him and decidedly sets him up. A and B have each performed a different kind of feeling response.

What kind of interaction then is a feeling? Notice that neither A nor B has done anything to produce an effect upon the stimulus object. Rather, the stimulus object has decidedly produced a change in them. It is for this reason that we call feeling behavior affective responses.

Even when our feeling responses are most active and energy consuming they have no effect upon the stimulus object. The reason is that affective responses are activities in which the person is responding above all with internal mechanisms. We can well understand, then, why in the older psychological tradition feeling activities were described as tones or states of an organism instead of being recognized as organized reaction systems.

The difference between affective and effective interactions are indicated in the accompanying diagrams. The fact that the person is affected is shown by the curved arrow pointing toward P, whereas in the effective interaction it points toward O, the stimulus object. It will be noticed that this comparison holds only between feelings

and overt behavior segments, since in implicit responses there is never any definite effect produced in the stimulus object.

Affective Behavior Segment	Effective Behavior Segment
$R \longleftrightarrow S$	$R \longleftrightarrow S$
$P \longleftarrow O$	$P \longrightarrow O$

Analysis of a Feeling Reaction System

We have defined affective behavior as action in which the result occurs in the responding organism rather than in the stimulus object. Since affective action is thus internal our next enterprise must therefore be to examine an affective reaction system. We must find out what sort of behavior configuration it is.

Shall we conclude that in the effective response the muscles operate and that in affective activity they do not? This is impossible. The organism always acts as a totality; consequently there is muscular activity in all action, no matter of what type or degree. From our study of reaction systems (Chap. 2) we learned that it is really a question of what factors in the reaction system are most prominent.

Feeling responses are predominantly intraorganic or visceral; that is to say, they involve mostly glandular and smooth muscle action. When performing feeling responses there is considerable secreting activity, increase or decrease of salivary fluid, flow of tears, adrenin secretion, changes in the rate of heart beat, blood pressure, and respiration. We must add, too, that the autonomic nervous mechanisms are quite prominently involved. The prominence of visceral or glandular factors consequently serves as a diagnostic sign for affective responses. When any response involves a predominant operation of the internal or visceral components we may conclude that it is an affective reaction. In the accompanying table are set down in parallel form the comparative stress of components in the effective and affective types of reaction systems.

Affective Acts are Both Precurrent and Final

Let us study once more the two students interacting with their respective marks. Notice that the feeling responses in both cases constitute final reaction systems in response patterns. As usual

these reaction systems are preceded in the behavior pattern by attending to and perceiving the marks constituting the stimulus objects. The feeling reaction system then consummates the response pattern.

Comparison of Behavior Configuration in Affective and Effective Responses

Reaction System Components	Affective (rs)	Effective (rs)
Discrimination	+	+
Attention	+	+
Feeling	+++	+
Striated muscle action	+	+++
Smooth muscle action	+++	+
Glandular action	++	+
Skeletal action	+	+
Receptor action	+	+
Effector action	+	+
Autonomic neural action	+++	+
Central neural action	+	+++

Such are typical feeling behavior segments. But there are variations in the performance of affective behavior. It may also be precurrent to some other consummatory reaction system. Let us consider that the F student instead of merely becoming subdued and depressed might have torn the record sheet off the board and trampled on it. In this case the feeling response which we have formerly called the consummatory reaction system would be but a precurrent factor in the response pattern, which would be consummated by the tearing and stamping reaction systems. This form of behavior segment in which the feeling configuration is only a precurrent action is typical of numerous situations in which affective or feeling conduct has a decided influence upon other kinds of behavior. For example, the tone of voice with which we answer a simple yes or no depends upon the feeling that is stimulated by the question. This affective influence can go farther, as when a feeling of resentment following the perception of an insulting word results in striking the person who uttered it.

Simultaneous Affective and Effective Adjustments

Compare two students in the biological dissection class. Each performs the responses of handling the specimens and dissecting them. But in the case of one student, the formalin-preserved specimen not only stimulates the effective responses of manipulation, but each time he touches the frog he is at the same time stimulated to recoil repulsively. For this second person there inheres in the object, stimulus functions arousing simultaneously both affective and effective response patterns.

How Many Kinds of Feelings are There?

During the mentalistic domination of psychology (see Chap. 1) feelings were regarded as psychic qualities. Some mentalists regarded these qualities as independent elements comparable to sensation qualities, while others thought of them as simply tones of sensations. Both types of mentalists, however, agreed that there were only a few of these qualities. Most mentalistic psychologists said there were only two, which were set over against each other like the poles of a magnetized bar, pleasantness and unpleasantness. The American psychologist Royce rejected this one dimensional idea of feelings and added two other opposites—namely, excitement and calm. Wundt, the famous German psychologist, added a third dimension of feeling elements, making room for strain and relaxation. This made six feeling qualities in all.

When we study feelings as definite interactions between persons and stimulus objects it seems absurd to limit the number of feeling behavior segments in this way. Only a little reflection convinces us that our language is hopelessly impotent to supply us with names with which to designate the various species and varieties of feelings. The number of distinct affective behavior segments runs into the high thousands.

Affective Behavior Varies in Complexity

Of the many affective responses we perform, some are very simple while others are correspondingly complex. When some things stimulate in us genuine affective responses we are merely quickened in our movements and take on a more energetic behavior tone, or our behavior becomes slumping or depressive. Similarly,

when we are pleased or displeased, amused or simply annoyed, our affective responses are all comparatively simple.

On the other hand, consider yourself when you are hopeful, awed, inspired, indignant, discontented, and when you love or hate. There is hardly any comparison between these complicated activities and those we have already mentioned. These two sets of feeling responses serve to suggest the great range of affective activities.

Feeling Responses Vary in Intensity

Unlike other psychological behavior, the intensity with which feeling responses are performed constitutes a definite feature of their behavior pictures. In some cases the degree of intensity goes so far as to mark off one type of affective interaction from another. Probably the only difference between the action of being pleased and being delighted is the greater intensity of the latter.

In other cases the intensity of performance only contributes one among a number of differentiating factors. When we are horrified we respond much more intensely to a stimulus than when we are sad, but the intensity difference constitutes only an item of variability in two totally different behavior pictures. The same observation can be made when we compare anger and disappointment, or fear and displeasure.

We can account for the importance of intensity in feelings on the ground that they are primarily internal responses. And so while feelings are no less adjustments to specific objects and conditions than any manipulative form of interaction, still the intensity with which they are performed reveals their organic nature.

There is still another point touching the intensity of feeling responses. The same form of feeling reaction varies in intensity when performed under different circumstances. For instance, the same object will not stimulate so violent a fear reaction when we gradually come into contact with it, as it does if we come upon it suddenly. It is a wise provision of military training which by degrees prepares soldiers to meet the enemy.

The setting of the affective stimulus exerts a definite influence upon the intensity of the response. The child may fear the dog even when he meets it while holding his mother's hand, but the reaction is much less intense than when he faces the dog alone.

What the person is doing at the time is generally reflected in any succeeding feeling response. If he is already performing

affective behavior the influence is especially marked. When we are elated by some good news we have heard, the antics of our puppy please us much more than would otherwise be the case. Contrariwise the sadder we are the less does good news excite and elate us when we first hear it.

Time heals all. No matter how intense our griefs may be at first, they are normally assuaged with the passage of time. Soon after the death of one of our dear ones any object that has belonged to him acts upon us as a substitute stimulus to call out a prostrating response. But the farther the event recedes in time the milder becomes our affliction.

On the other hand, time may produce an increase of sorrow or hate. When the flight of time brings us more and more frequently into contact with the object of our hate or sorrow, our response becomes much more intense.

In general, the intensity of affective responses is dependent upon the degree of removal of the person from contact with the stimulus object. The implicit performance of affective reactions may increase or decrease their intensity. Just how the distance that separates a person from his stimulus object affects feeling behavior depends upon numerous specific behavior conditions.

Affective Responses Stimulated by a Wide Range of Things

Feeling interactions constitute a large share of our psychological behavior. It follows, therefore, that the stimulus functions for feeling responses reside in every possible sort of thing and circumstance.

It is hardly necessary to mention the stimulating effect of *things* and *persons* in view of our omnipresent affective responses to all the interesting, beautiful, and exciting things around us, and the equally frequent responses of love, hate, and anger which normally are only interactions with persons.

We must point out, however, that *single qualities* of things and persons can arouse feeling reactions as well as complete objects themselves. For instance, it may be the color, size, or shape of a bowl that pleases or displeases us.

No less are our feelings aroused by *contrived* things as well as natural objects. A smooth running motor, a symphony, or the painting of a great master elicits undiminished delight. Let us not

overlook either the power of *abstract* things to stimulate feeling behavior, as exemplified by the exclamation of Kant when he wrote, "two things fill me with awe and reverence when I contemplate upon them, the starry heavens above and the moral law within."

When we despair over the loss of a prized possession or the failure of a cherished enterprise we find the stimulus function in some *event*. Examples are the victory or defeat of our soldiers, the miscarriage of justice, the occurrence of an earthquake, plague, or other cosmic calamity.

Exceedingly common are the affective responses aroused by *conditions* of all sorts. Foremost are those physiological changes, sometimes imperceptible, which stimulate the generalized forms of feelings called moods. A very different type of condition eliciting feeling responses is *monotony*, which brings about disagreeable results in the individual. It is well known that even the most attractive of pictures or the most interesting of conversations induces a marked feeling of numbness or ennui when one is forced to attend to it too long.

And finally we may consider the affective stimuli residing in the *actions* of things or persons. Successful acts that we perform stimulate pleasant and exciting feelings, while those that are hindered or frustrated produce depressing and unpleasant responses. The acts of others, too, for example, the dancing and acting of entertainers, induce pleasure and delight. But even our everyday responses in which no success or failure is involved, such as eating, walking, and conversing, provide adequate stimulation for the more simple forms of feelings.

Feeling Responses are Easily Conditioned

Since affective responses are primarily internal reactions they can easily be attached to other stimulus objects than those with which they were originally connected. Accordingly feeling responses are probably the most easily conditioned of all our complex responses.

It is a frequent observation that when we love someone the response not only becomes attached to the person, but also to many objects belonging to him. The exaggerated form of this type of conditioning is called fetichism, as when a lover is stimulated by an article of clothing belonging to the loved one, to perform the same feeling responses as he does to the owner. This conditioning effect

accounts for the fact that once we begin to hate a nation we hate its laws, its history, and its language. At the basis of much of our race prejudice lies the fact that when we have acquired an adverse feeling toward some member of a group we tend to attach that response to other members of his society.

Feeling behavior is subject to substitution as well as conditioning. Objects that at one time amuse and delight us may subsequently call out in us reactions of dread and disgust. Everyone knows how love for persons may be substituted for hate, and vice versa.

Affective Responses are Personal and Social

Our feeling responses are acquired in the same manner as are all our other ways of acting. But it is worth noting that feelings, too, like our other behavior, may be conventional as well as personal.

The less satisfactory conditions of life induce us to acquire and perform the exciting acts of dread and agony, or the ennervating responses of despair. The more even tenor of satisfactory living brings in its train less violent and more desirable affective equipment.

Just how things affect us is mostly a matter of the kinds of human groups with which we happen to be in contact. We may be culturalized to love and hate things and persons which call out opposite responses in individuals from other families or national groups. Objects that arouse anger and fear in the members of one community may simply not do so for members of other groups, or stimulate quite other responses. An American is disgusted by the food which brings keen enjoyment to the Frenchman.

The same is true for the intensity of affective performance. The conventions of one society bring forth the deepest grief in the face of death while those of another call for the coldest indifference. In the case of both personal and conventional feeling situations, the type and intensity of feelings are, of course, conditioned by the intimate details of behavior circumstances.

Classification of Affective Behavior

Feeling interactions may be differentiated on the basis of a number of criteria. They differ in the kind of adjustment they represent; that is, their behavior pictures vary. The kind of stimulus object with which the person interacts also marks off the different

feelings from each other. Again, the intensity of the response is a distinguishing characteristic. On the basis of these criteria it is possible to arrange a series of feelings, the members of which are very different from each other.

Passions.—Feeling activities like loving, hating, loathing, despising, being jealous or envious may be put into a single class, since they all share the following characteristics. As adjustments they are well organized, highly active, and usually intense. Furthermore, they are very definitely directed toward a specific object, usually a person. For the most part, too, they consist of responses that are prolonged in their performance, although sometimes they are fitful and momentary.

Climactic Feelings.—These feeling responses have a definite temporal course. They are engendered more or less suddenly, rise to a climax and then show a definite release. Specific instances are sex excitement, striking disappointment, overwhelming surprise, fitful anger, and sudden indignation.

Affective Sentiments.—Every person harbors in his behavior equipment various feeling traits. These constitute modes of affective adjustment which operate periodically when their corresponding stimuli are presented. Examples of such affective sentiments are patriotism, shyness, compassion, timidity, decency, etc. They are for the most part conventional ways of acting, since they are shared with other persons.

Moods.—Among the best known of the affective responses are the comparatively simple moods. These diffused feeling responses have a great effect upon our other activities. Being so unorganized and so little directed toward specific objects, they carry over from one situation to another with the result that often we are at a loss to discover the actual stimulus that elicited them. This is true especially when, as frequently happens, the stimulus for a blue or rosy mood consists of the person's general hygienic condition.

Affective Dispositions.—To speak of a person as a pessimist or as one who always looks on the bright side of things is to point out a permanent behavior characteristic. It is by such dispositions that we sometimes identify individuals. Persons are characteristically sympathetic, forbearing, indifferent, or antipathetic.

Bases of Affective Individual Differences

Individuals differ in their affective performance no less than in any other form of behavior. We all know the sensitive person who jumps from the crest of one wave of exciting feeling to another, or periodically falls into the trough of melancholy or despair. Such an individual contrasts markedly with those who live a life of dead calm and indifference.

We can account for these differences on the basis of two outstanding conditions.

First, the reactional biography of the person. A child who has been constantly stimulated to be tender with animals is much more intensely affected by the cruelty practiced upon his pets than the child who has not built up such feeling traits. Similarly, the individual who has no training or knowledge of art is not moved even by the most wonderful of the artist's creations.

Secondly, variations in affective behavior are located in organic make-up and functioning. While it is difficult to say just how much our glandular functioning affects our behavior life, it doubtless has a considerable effect upon both the acquisition of affective equipment and its later operation. Similarly, the whole gamut of visceral functions and the general hygienic conditions of the persons greatly influence what kind of feeling responses he will perform.

Some Experimental Studies of Feeling

The earliest laboratory studies of feelings were classified under the headings of impression and expression methods.

The Impression Method consisted of calling out feeling reactions in individuals by presenting them with appropriate stimulus objects. A typical example is to present different pairs of colors and ask which the subject prefers. The assumption is that each color will separately call out a feeling response, or that one will and the other will not. This technique is called the method of paired comparisons. In a typical experiment twenty-five pairs of colors are presented, each one matched with every other. In this way the experimenter can discover which particular color receives the highest rating, which the next, and so on. In such experiments it is assumed that the feelings aroused are either pleasantness or unpleasantness, or greater or lesser intensity of either.

The Expression Method was designed to discover correlations between such physiological conditions as blood pressure, blood volume, and breathing, and the so-called psychic feeling states. The idea that physiological conditions were expressions of psychic states suggested the name expression method for this experiment. It consists essentially of offering the subject a stimulus object such as an odor or picture, with the aim of evoking an affective response.

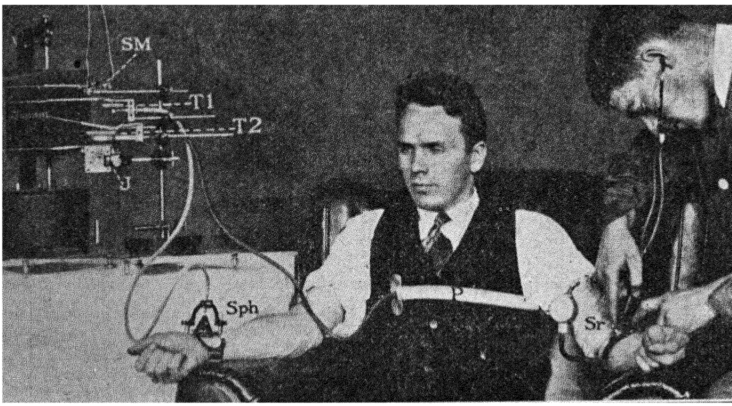


Fig. 44—The Pneumograph, Sphygmograph, and Sphygmomanometer, with Recording Devices.

The model of *pneumograph* here shown (Sumner), *P*, consists of a coiled spring in a sealed rubber tube strapped snugly about the chest. Movements of inspiration and expiration stretch and relax the tube, drawing or driving the air in the small tube that connects with a recording tambour. The recording *tambour, T2,* is a metal chamber covered with a rubber diaphragm, across which lies a free-moving pointer. Air on entering the chamber pushes the diaphragm and pointer upward and on leaving draws them downward (inscribing the third line). The model of *sphygmograph* shown (Mackenzie), *Sph.* is a cone-shaped tambour, the rubber diaphragm of which is fitted closely over an artery, so that beats there are pneumatically conveyed through a tube to a second recording tambour, *T1* (inscribing the second line). The pointers of the recording tambours bear against smoked paper mounted upon the revolving drum of a *kymograph, K,* operated by clock work. Simultaneous tracings are made by a *signal marker, SM,* operating electrically to indicate points when a stimulus is given (top line), and by a *time marker* (Jacquet model shown), *J,* indicating seconds (bottom line). The model of *sphygmomanometer* shown (Tycos), *Sr,* is a silk-covered rubber bag wrapped about the upper arm and inflated by a bulb (held in examiner's left hand). The air pressure is registered on a dial slung in front and connected to the bag by a tube. From Dashiell, *The Foundations of Objective Psychology.*

The physiological changes are then recorded with instruments borrowed from the physiological laboratory:

The height and rate of pulse are measured by the sphygmograph. (Fig. 44.) This instrument consists essentially of an air-containing

chamber covered by a rubber membrane, the rising and falling of which can be transmitted by a tube to a revolving smoked drum.

The standard instrument in use today by physicians to record blood pressure is the sphygmomanometer, or sphygmometer, a rubber bag which is tied around the upper arm and inflated until the blood pressure in the brachial artery is matched. The systolic pressure is read from a dial or a mercury manometer. See Fig. 44.

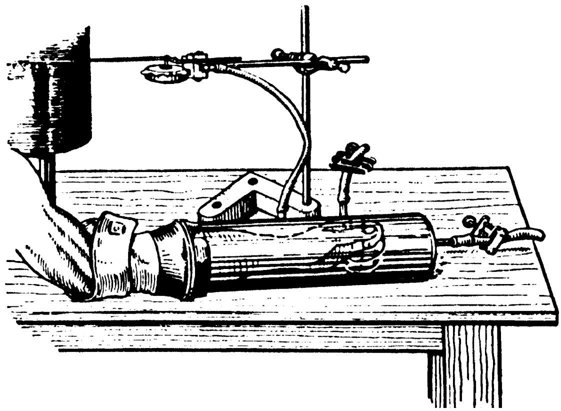


Fig. 45—A plethysmograph. The hand and forearm are enclosed in a glass cylinder from which the contained water is prevented from escaping by means of a rubber cuff. A tube leading off from the cylinder connects with a tambour so that an increase or decrease of volume can be recorded. An increase in the volume of the arm resulting from vasodilation drives the water toward the recording instrument, while a decrease resulting from vasoconstriction draws the water away from the tambour. In this manner the marker moves up or down on the smoked paper, producing a wave record.

The pneumograph records the course of breathing. The Sumner type of apparatus shown in Fig. 44 is a convenient form which can be tied around the chest or abdomen and connected with the kymograph drum to indicate the rate and changes in chest or abdominal breathing.

Blood volume can be measured by the plethysmograph of which there are several varieties. In Figs. 45 and 46 are shown a recent model with an indication of how it operates, and a record obtained by such an instrument in a mathematical, problem-solving situation.

Results and Interpretation of the Expression Experiment.—The early experimenters thought they had discovered conclusive correlations between physiological and psychological phe-

nomena. Having previously assumed that there were only two kinds of affective psychic states—namely, pleasantness and unpleasantness—they thought that the bodily functions paralleling pleasantness were inevitably heightened and strengthened, while those paralleling unpleasantness were weakened and depressed. But it was soon ascertained that the opposite effects were also obtained. Pleasant feelings indicated weakened and depressed physiological

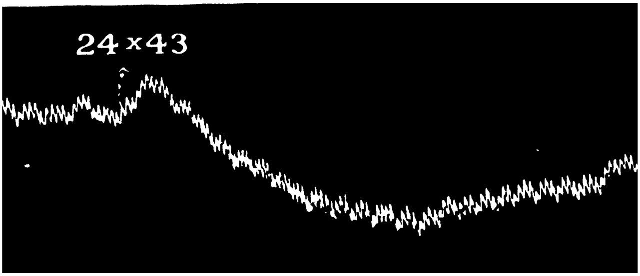


Fig. 46—A plethysmographic record of a person before and after being stimulated to perform an arithmetical problem. Before being told to multiply 24 by 43 the curve shows only changes due to breathing and heart beat. Afterwards there is a decided vasoconstriction shown by the depressed curve. From Howell, *A Textbook of Physiology*, Saunders, publishers.

action, while unpleasant feelings showed a heightened or strengthened pulse and breathing.

The value of the expression method turns out to be merely of general scientific import. It teaches us that no experiment can be better than the presuppositions upon which it is based. We find two wrong postulates here. First, the parallelistic theory is without foundation; and secondly, there are no psychic states to be expressed by physiological action.

Feeling Pattern.—The more recent experimenters have turned away somewhat from the crude notion of physiological or bodily expressions of psychic states. Instead they have asked the question, is there a definite organic pattern in feeling behavior?

In these experiments certain refinements were introduced in the ordinary physiological measurements used in the traditional expression method. For example, instead of recording merely the course of breathing, the inspiration-expiration ratio was used. In regular breathing, inspiration requires about one half the time of expiration, so that the normal I/E ratio is 1 to 2. In other cir-

cumstances, such as singing, inspiration may require still less time than expiration, thus giving a smaller ratio, say 1 to 5, or 1 to 6. The changes in this ratio a number of investigators have attempted to correlate with feelings.

For instance, Benussi used this ratio in an attempt to study the feelings involved in truth-telling situations. He claimed that when a person was telling the truth his I/E ratio was higher just before answering a question than afterwards, whereas when he told a lie the ratio was definitely lower before answering than afterwards. He accordingly claimed that by the measure of this ratio he could always detect falsehoods. Burtt and others who repeated this experiment found that they could not get anything like comparable results.

In addition to the traditional physiological measurements, psychologists have also added others; among them, (1) the hydrogen ion concentration (pH) of the blood, (2) changes in metabolism, (3) variations in gastro-intestinal activity, (4) changes in glandular secretion, and (5) the electrical conductivity of the skin.

A large number of investigators have attempted to connect the problem of electrical conduction with feelings. A typical experiment consists of connecting the subject or reactor in a circuit with a galvanometer and then stimulating him. The deflections of the needle indicate the passage of a current. When a battery is connected in the circuit the organism's electrical resistance can be determined. These resistance phenomena have been studied by psychologists under the heading of psychogalvanic reflexes. An elaborate instrument with many advantages over the ordinary galvanometer for measuring bodily resistance is shown in Fig. 47.

This device, developed by Prof. R. C. Davis,[1] uses vacuum tubes for obtaining an accurate and readable measure of the reflex, which is an increase in the electrical permeability of the skin. Such a change occurs when a person is subjected to almost any form of stimulation. An imperceptible current is passed through the subjects, usually through the fingers, the current being held constant by means of an emission limited vacuum tube. The intensity of this current (about .1 milliampere) is indicated by the meter at the left.

The fluctuations in potential drop across the subject are magnified by a d. c. amplifier and cause the needle at the extreme right

[1] See Ability in Social and Racial Classes, Century, 1932.

to move across its scale. Deflections can be translated into ohms.

The total potential drop across the subject is indicated by the middle meter. From this can be computed the absolute value of his apparent resistance, which is usually valuable for the interpretation of the changes indicated by the third meter (extreme right).

RESULTS AND INTERPRETATIONS.—The net results of all these experiments are doubtful. But this is clearly due to the fact that they are based upon the assumption that there are isolated physio-

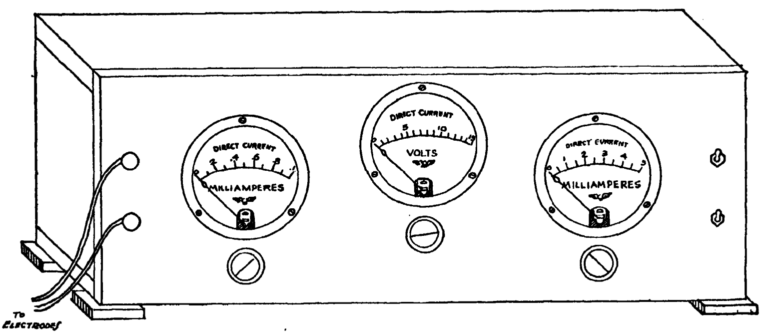


Fig. 47—The Davis apparatus for measuring body resistance. This instrument has many advantages over the ordinary galvanometer for work on the psychogalvanic reflex. Description in text. Illustration by courtesy of Prof. R. C. Davis and Mr. W. A. Livingston.

logical conditions or changes which constitute feeling responses. The experiments suggest that what needs to be done is to attempt to study total behavior configurations. Changes in blood pressure, pulse and breathing rate are participating events in complex psychological interactions with specific stimuli. These experiments therefore have a positive value in demonstrating that psychological phenomena are much more than physiological actions. In sum, they teach us that we cannot abstract certain physiological data and then search for something with which to connect them. What we must look for is a large total reaction system or response pattern operating in interaction with a stimulus function.

An experiment that appears to indicate that feelings must be regarded as total interactions of the individual with a stimulus object or situation was recently performed by Kellogg[2] at the Indiana

[2] The effect of emotional excitement upon muscular steadiness, *J. Exp. Psych.*, 1932, 15, 142-166.

University laboratory. This investigator recorded the steadiness reactions of four sets of subjects before and after being placed in the following situations. The members of one group were dropped backward in an improvised chair and tipped suddenly to a 60° angle; those of another were required to cut a living albino mouse into two; a third group had a five foot live snake put into their laps; a fourth was obliged to handle bloody calves' brains. Only about half of all the subjects were intensely affected in their steadiness. Moreover, those intensely affected reported a large variety of different responses. It may be safely concluded that each individual was responding to the objects and situations involved according to his or her personality equipment built up in a particular reactional biography.

The James-Lange Theory of Feelings

No student can go far in the study of feelings until he comes across the famous and brilliant theory of William James,[3] the American psychologist, and Carl Lange, the Danish physiologist. We do not, however, discuss this theory because it is famous, but because a consideration of it helps to illuminate the subject of feelings.

The essence of the theory is that organic changes are of great importance in feeling behavior. We must recall that when the theory was developed about a half century ago the doctrine of biological evolution was just beginning to make its influence felt in the field of psychology. Up to this time it was presumed that the primary emphasis in the study of feelings should be laid upon the mental state which manifested itself in bodily disturbances.

Lange, however, brilliantly insisted upon the tremendous place which the organic and especially the visceral disturbances occupied in the affective picture. James then proclaimed that it is a faulty idea to regard the mental state as the primary factor in feelings. To him it seemed rather that the psychic phase of the affective situation was the pale cast of reflection upon the tremendous organic disturbances. He declared accordingly that contrary to the general description in which it is said "that we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike," the "more rational statement is

[3] James, W., and Lange, C. G., The Emotions, Williams and Wilkins, 1922.

that we feel sorry because we cry, are angry because we strike, are afraid because we tremble."

Now although we may give these writers full credit for thinking more in terms of the complete behavior of the organism than was true before they propounded their theory, we may still profit by the half century of further psychological investigation to introduce some necessary corrections.[4]

Let us notice that the theory is based upon a division between the bodily action of the organism and the psychic state which follows. There are two serious objections. In the first place, what is the psychic state which is distinguished from the general reaction of the organism? Is this anything more than a name for a total behavior situation which is set beside the action? Does the fear phenomenon consist of anything more than what the organism does when it trembles, runs, etc., in other words, interacts with a stimulus object?

In the second place, the James-Lange theory implies that, so far as behavior is concerned, feelings consist mainly of visceral changes. This view has been disproved by various experimental studies. Sherrington operated upon a laboratory dog, which had previously performed joy, anger, fear, and disgust responses, in order to detach the viscera from the rest of the organism. The fact that the animal performed similar behavior after the operation implies that behavior always consists of total reactions.

Cannon and his coworkers removed the entire sympathetic division of the autonomic system of cats and reported that in these animals "all superficial signs of rage were manifested in the presence of a barking dog—hissing, growling, retraction of the ears, showing of the teeth, lifting of the paw to strike, except erection of the hairs." This experiment shows that unless the operation prevents the animal from doing an action at all, it can perform such action as a unified though mutilated organism.

A very significant experiment was that of Marañon[5] who succeeded in inducing persons artificially to perform what they described as feeling reactions. After injecting adrenalin the subjects reported that they "felt as though they were afraid," or "were

[4] We are passing over the criticism that the James-Lange theory makes no distinction between the complete disruption of the emotional act (see Chap. 14) and the organized response of feeling behavior.

[5] This experiment was repeated by Cantril and Hunt, and by Landis.

awaiting a great joy," or "as if they were going to weep, without knowing why." This experiment demonstrated that feeling behavior consists of more than the response of a person. It must also be a definite interaction with stimulus objects. Without the interactional conditions this behavior only simulates genuine feelings.

More recently Cantril and Hunt repeated Marañon's experiment and concluded that true emotions (feelings) were aroused in some of the subjects. Their article, however, indicates that at most those subjects who reported emotions might have been substitutively stimulated by physiological changes to perform implicit feeling responses. It appeared to be necessary for at least some of them to make associations with former experiences. They seemed to be recollecting vividly what happened when they were afraid. For this reason probably the subjects refer to their experiences as "cold emotions." That they were not performing clear cut feeling responses is indicated also by the fact that when the subjects reported they were afraid they were not afraid of anything in particular. Cantril and Hunt write further that for most subjects the situation must possess certain logical relationships in order for them to experience a genuine emotion (feeling). It is probably not incorrect to say that at most the adrenalin produces such a physiological effect that the subjects verbally supply many of the factors that we know to be involved in a feeling behavior situation.

CHAPTER XIV

EMOTIONAL INTERACTIONS

The Typical Emotional Interaction

You are driving a car. The practically automatic behavior involved enables you to admire the landscape, while still keeping a sharp look-out for other cars. As you speed on at a rapid clip you suddenly find yourself about to cross a railway track close to the moment that the crack limited is getting there. What happens? If you could study your behavior carefully at such a time this is what you would find. Your efficient behavior of a second ago becomes momentarily but completely disorganized. All your activity which previously was operating so smoothly now becomes totally disrupted. There is a moment, in fact, when you perform no psychological behavior at all. This is the period of the specific emotional behavior segment. Should you not recover from this disorganized and disrupted condition you probably would not live to tell the tale. But if good fortune has not deserted you there is a rapid recovery; so that the emotional behavior segment proper lasts for only a brief part of a second. Then a new stimulus function calls out another response, which may be the application of the brake, accelerating the motor, or jumping from the car. As soon as one of these activities begins the emotional shock is over.

When this psychological paralysis occurs the biological mechanisms assert themselves. The individual becomes reduced practically to a physiological organism. Accordingly all sorts of violent organic and visceral changes enter into the situation to replace the absent psychological responses to stimuli. During an emotional seizure sweat may issue from every pore; the heart thumps as though it would crash through the ribs; the salivary glands stop secreting, leaving the mouth and throat membranes dry. One's legs and arms tremble; blood rushes from the face leaving the emotional person pale as a ghost. Notice that these physiological

activities, which we may call replacement reflexes, though they result from a disruptive condition, last for a considerable time after the emotional event is over. As we should expect, the more violent the reflexes, the longer they persist.

Emotional Behavior Segments are Atypical

The disruption and disorganization of emotional behavior make it very different from the ordinary behavior pattern. We may therefore regard the emotional behavior segment as absolutely atypical, for both of its precurrent reaction systems (attention, perception) operate without being consummated by a final reaction system. Because the latter is impossible or unavailable the person becomes shocked and disrupted. An emotional response may therefore be defined as a case of no-response, in the sense that the appropriate final reaction system does not occur. There is no definite correlation of a response and a stimulus function.

Systematic Analysis of the Emotional Event

Emotional behavior can be best understood by analyzing a large situation of which it is a part. In the case of emotions it is not sufficient to describe a single behavior segment, for we must consider what the person does before and after the emotional seizure. Our analysis must therefore comprise four behavior segments which occur in rapid succession.

(1) *Pre-Emotional Behavior Segment.*—Typical emotional behavior segments are affected by the interactions which immediately precede them. These preceding interactions which we call pre-emotional behavior segments pave the way for emotional behavior segments proper. When the individual is not occupied with some object just before the emotional stimulus appears, it does not come to him with the overwhelming force that is typical of most emotional situations. Thus we see that the violence of the disruption depends definitely upon the suddenness of the appearance of the emotional stimulus, and this in turn depends upon the kind of pre-emotional behavior segment that precedes the emotional interaction.

(2) *Emotional Behavior Segment Proper.*—In presenting our train illustration we have already implied that the emotional

stimulus function resides in an overwhelming and suddenly appearing object. Now so far as the response pattern is concerned the precurrent phases operate in an orderly and regular way exactly as in any other behavior segment. You attend to the stimulus object and then perceive it. But now instead of continuing this organized pattern and performing the appropriate final reaction system, the latter does not occur. When the person is equipped to perform the consummatory reaction and does so, there is no emotional shock.

(3) *First Post-Emotional Behavior Segment.*—The emotional shock is effectively terminated by the functioning of a new stimulus. It is the promptness of operation of the new stimulus function that may be the condition for the person's life being saved. There are many ways in which the individual comes into contact with new stimulus objects. Some one may yell to him, "Step on the gas." Or his foot may accidentally come into contact with it. Again, in the brief second that has been passing, the individual's range of vision has changed so that he sees how to get across the track. Whatever the new stimulus may be it brings about the person's recovery and initiates a new behavior segment.

(4) *Second Post-Emotional Behavior Segment.*—Now the car is lunged forward, the track has been crossed, the train has passed. Still a new stimulus appears, in the form of these events that have just happened. The response is the individual thinking or saying to himself, "That was a lucky escape." The behavior segment may be described as a reflection upon what has taken place. The important point to notice is that even though only a brief second has passed since the first initiation of the emotional disruption the individual has since then passed through two behavior segments.

Mild and Violent Emotions

In scientific description it is often advisable to stress the extreme occurrences of an event in order that the essential facts may be observed. It must not be overlooked therefore that the violent emotions constitute the crudest and most extreme form of such happenings. At the other end of the pole lie the mild emotions.

The general behavior picture of the mild emotions is the same as the violent ones, but the disturbance and disorganization of

the individual are not so intense. For example, the student who is unexpectedly called upon to answer a question goes through the same disruptive experience as if he suffered a violent response, only in a mild form. The paralysis and interruption of behavior are quite definitely present but in moderation. The replacements are also there though they are sometimes so mild as to escape detection.

Mild and violent emotions can be effectively distinguished by considering the total, general, behavior situations in which they occur. For the most part, mild emotions are performed under interpersonal conditions, that is, when we interact with persons, as in our embarrassment illustration. Violent emotions, on the contrary, take place mostly when the individual is interacting with natural phenomena, as when we meet a bear in the woods or come across a snake in the meadow. The difference between violent and mild emotions parallels the contrast between escaping from some danger to life and limb, as over against committing a *faux pas* in a social setting.

We must not, of course, stress too much the absolute correlation of violent emotional situations with natural circumstances. It is quite possible that under the stress of social conditions the emotional disturbance is much more violent than in the case of some great natural danger. It is not difficult to imagine the soldier going to pieces with much greater violence when detected by his commander in an action compromising his military standing, than would be the case if he suddenly found himself attacked by the enemy. There are greater dangers lurking in social conventionalities for the "proper" person, than in the exigencies of nature.

Emotions and Feelings

Emotional interactions are constantly confused with feeling behavior. There is, however, a definite and effective criterion for distinguishing between the two when we examine the different organizations of these two response patterns.

In the case of the affective (feeling) behavior segment the response pattern is orderly and complete. The precurrent reaction systems, whether they are few or many, are definitely followed by a consummatory reaction system which completes the pattern. Not so in the case of the emotional behavior segment which, as we have already pointed out, lacks a consummatory response.

Of course, there are also differences in the stimulus functions that arouse the two types of conduct. If we study the total interactional picture in each case we venture the assertion that there will be no necessity for confusing these two widely differing types of interaction even when they are most alike. These similarities we shall examine in another section.

So important is the distinction between emotional and feeling interactions that we must inquire into the basis for confusing them. The most outstanding similarity is that in each case there is considerable visceral activity. But in feeling responses these visceral activities are organized in a definite configuration; and as factors in differential responses to stimuli they are, of course, psychological activities; whereas in the emotional situation the visceral components are a confused mass of action and are consequently primarily biological in character.

Another basis for confusion is that feeling responses may also be quite violent in action and display a behavior picture of great excitement. We have, however, already pointed out that intensity of performance is not an absolute mark of emotional conduct. It is the absence of a breakdown of behavior in violent feeling reactions which differentiates them from an emotional seizure.

Criticism of the No-Response Description

When the student begins the study of emotions he enters upon one of the most intensely fought battlegrounds of all psychology. It is not surprising then that exceptions should be taken to the statement that the primary characteristic of emotional behavior is the breakdown of the interactional process.

In this connection Stratton[1] cites several occurrences which he believes prove that emotions are not necessarily the breaking down of the individual. The first of these events is related by an aviator, and happened while he was performing stunts as part of his training.

Reports the aviator, "My first stunt was a loop, and this I went through all right and straightened out. Then I found that my elevator-control was stuck. I went up on the rise for a second loop, but instead of letting my ship whip-stall and thus running the risk of permanently damaging my controls, I kicked the rudder to the right and dropped into a tail-spin.

1 An Experience During Danger and the Wider Functions of Emotions, in Problems of Personality, Harcourt, Brace, 1925, pp. 47-62.

"It was at this time that a dual personality came into play. I had a rapid survey of my life, not as though I were looking at scenes of my past, but as though I were doing and living them again.

"Yet I was conscious at the same time of having to manage my ship. For as soon as I started down in the tail-spin I realized that I had a certain amount of time, and I went carefully over the different controls. I tried the rudder and found that it worked all right. I then moved 'the stick,' and its movements showed that the ailerons were working, but that the elevator was stuck. I thought that the elevator-wire might have become entangled in the leather slot where the elevator-wire goes through the covering to the outside. So I pushed the stick slowly and steadily forward to overcome such an obstruction. In shoving forward on my stick I felt the tension of my belt which showed the control was in some way entangled with the belt. I reached around and found there the loose end of a wire used to support the triangle of the safety-belt, and which had been left too long and become entangled in the wire which worked the elevator. I pulled this loose end out, and my elevator then worked perfectly, and I straightened out my ship. I was then at a height of about 1,500 feet, having fallen about 4,000 feet since the accident began."

Upon the basis of this incident Stratton declares that the emotional condition really helps to organize movement, thought, and recollection. But notice in this report as quoted, the aviator says nothing about fear. Let us assume that he was afraid. But when we use this term must we say he was performing emotional behavior? By no means. The term here is obviously employed in the everyday sense in which it is synonymous with feeling. We are all the more convinced that Stratton is confusing emotions and feelings since he admits that disruption and paralysis do occur in violent emotions.

The second occurrence is related by the same aviator whose motor stopped while he was in an area of artillery fire. He succeeded in landing with some damage to his ship. Here again there was some thought and recollection; but when asked whether these interfered with his control of the machine, he replied:

"There was no discontinuance of attention to the machine at all, because that was the first thing. The fact is, I do a great deal more flying on the ground than in the air. I figure out certain tight places that I may get into, and how to get out of them. Then

when you get into a tight place, you automatically do the thing you figured out. Such was the case when I kicked the rudder and fell into the tail-spin. I had thought that out on the ground, and the rest was a matter merely of working it out at the time."

Must we assume that this is a case of emotional behavior, but which instead of being a paralyzing and disorganizing affair, is one that makes a person much more organized and effective? At best we can only allow that the aviator performed slight feeling responses. It seems that the presumption that emotions were present is based upon the danger situation. But, as we know, what a danger situation is psychologically depends upon the behavior of the person. So well prepared was this aviator to meet the exigencies by "flying on the ground" that he was equipped not to be emotionally shocked. In this sense the aviator exemplified the rule that whoever is equipped with final reaction systems to meet emergencies does not become psychologically paralyzed. If it is true that certain criminals can kill and be killed without the slightest emotional disturbances or even affective responses, we might look to this kind of equipment to explain the fact.

The importance of the present issue justifies us in referring to another occurrence cited by Stratton.[2] This is the case of an individual who once noticed that a child reading a paper near a fire was suddenly encased in a mass of flames. The former immediately jumped to the rescue of the child and performed actions exactly appropriate to the situation.

Granting that this was a case of genuine emotional shock, does this prove that emotions are organizing responses? By no means. The question here is what we mean by "immediately." Is there any evidence to show that this means jumping to the rescue before any disorganizing shock? As we have already pointed out, the emotional paralysis in no case lasts more than a second unless it is reperformed.

The Emergency Theory of Emotions

Those who object to the breakdown description of emotions adhere to a theory that emotions are beneficial behavior mechanisms developed by animals during their biological evolution in order to meet the emergencies of nature. The stock type of illustration is

[2] The function of emotion as shown in excitement, *Psych. Rev.*, 1928, 35, 351-366.

that when an animal is angered it is more energetic and can fight more effectively.

Cannon, one of the most prominent physiologists to adopt this utility theory, has made a number of studies to show the great organic and visceral changes that take place during the emotional experience.

Most of these organic changes center around the effect of adrenin, an internal secretion of the adrenal glands. Cannon points out that this hormone counteracts fatigue and increases the supply of sugar in the blood, thus supplying the organism with energy. Adrenin also accelerates circulation, adds red corpuscles to the blood, and at the same time makes the blood coagulate easier when a blood vessel is injured. In emotional excitement the respiratory mechanisms also operate to make the breathing deeper and more rapid, thus favoring attack in anger or escape in fear.

Setting aside all questions concerning the accuracy of these physiological findings, for they are disputed by some physiologists, we may ask whether these results argue for the utility or emergency theory of emotions. Is it not true that these organic conditions occur in all sorts of exciting behavior and not only in the case of feelings or emotions? Cannon points out that he uses the term emotion to include feelings, but as a matter of fact he includes under this term also pain and hunger, which are neither feeling nor emotional reactions. It is certainly clear that when the term emotion is made to cover all these behavior situations the organic changes mentioned occur when there are no emergencies and no danger to the organism. Here the theory proves too much.

There is another consideration which militates against the emergency theory. The proponents have neglected to mention organic happenings that not only are not useful, but positively deleterious. What emergency or protective purpose is served by vomiting or belching, and by the excretory functions which occur in such situations? These cannot be set aside as pathological manifestations of the emotional situation. It turns out that most of the materials brought forth to prove the emergency theory really consist of evidence to show that there are organic happenings in all psychological behavior.

But are there no utilitarian features in general emotional situations? There probably are. The emotional shock itself may sometimes be regarded as beneficial. When the individual suddenly

checks all his behavior he may all the more readily be prepared to do something different than he was doing before, but only, of course, if he becomes free from his dissociation and reconstituted quickly enough to meet an emergency.

The Classification of Emotions

If it is true that emotional activities are no-response behavior segments it is impossible to classify them because we have here only one series of essential characteristics. There is therefore only one kind of emotion—namely, a type of disruptive conduct: Any kind of classification consequently consists merely of the enumeration of the circumstances under which these disruptive activities occur. Here we cannot indicate as we do in other types of activity the differences in action while in the presence of different stimulus conditions.

This does not mean that all emotional events entirely duplicate each other. There are always plenty of variations in the way we are emotionally shocked, even when we must call the instances of such behavior by a single name, say fright or horror. Nevertheless, the distinctive emotional feature remains the same in all cases.

There is one important conclusion to be drawn from the problem of classification. We must guard carefully against the fallacy of confusing behavior facts because of the names we use to describe them. Thus such terms as fear, rage, grief, anger, or sadness may be used for emotional as well as feeling responses. Ordinarily such terms as grief and sadness have no manner of reference to emotional situations. And yet it is sometimes possible to designate emotional disruption and shock behavior with these names. We must simply guard against letting a descriptive term interfere with our appreciation of the differences in actual behavior circumstances.

Conditions of Emotional Conduct

Emotional seizures are not satisfactory forms of psychological adaptation. Can they be prevented from occurring? Undoubtedly there are conditions which favor or prevent emotional breakdowns. Some of these conditions primarily affect the organism, while others have to do mainly with the stimulus circumstances.

Personal Conditions.—We may mention first the individual's reactional biography. The training of a soldier involves consider-

able effort to induce him to develop psychological equipment which will prevent him from undergoing emotional shock when he meets the enemy. Ordinarily, an individual whose speed of reaction is exceedingly rapid will not be so readily caught without possibilities of responding in dangerous situations. Hence he will be less likely than others to undergo emotional disorganization.

Hygienic conditions of the individual have a great influence upon emotional situations. It is a familiar fact that the individual debilitated by severe illness is prone to become emotionally shocked upon the slightest provocation, while the healthy person is much more resistant to emotional disturbance.

STIMULUS CONDITIONS.—The individual who meets only with familiar circumstances is not apt to have his behavior disintegrated. Frequency of contact with objects which ordinarily condition the emotional seizure constitutes a potent preventive of such action. Social conventions of all sorts have a very definite influence upon the occurrence or non-occurrence of emotional seizure. The individual brought up in a society in which death is the utmost of terrifying happenings is much more likely to be emotionally shocked in facing it than the person in whose society death is regarded merely as an expected and inevitable event, or a desirable eventuality, as in the case of the Mohammedans who accept the doctrine of the Blessed Warrior. Incidentally, if emotional conduct is truly influenced by social circumstances, the doctrine of the natural utility of emotions quite definitely falls away.

Emotions and Expression

Students of psychology more than others must be on their guard against the pitfalls of language. What psychological fact if any is referred to by the phrase "expression of emotions," or by the reference to the "registration" of anger, fear, etc.? In the older mentalistic psychology, of course, the expression or the registration was presumed to be a bodily change correlated with a psychic process. Now that we take psychological phenomena to consist of interactions of persons with objects can the expression of emotions mean anything? The only legitimate meaning the term can have is a reference to what the observer can describe as the emotional seizure. When we study a person undergoing emotional shock we notice certain configurational changes in his behavior. We observe

definite postural action and movements, trembling, facial gesturing, and the paling or flushing of the face. By means of these evidences of a person's emotional behavior we can tell what reaction the individual is performing even when we have not been present during the whole interactional event. Such factors are the only "expressions" of emotions that an objective or organismic psychology can deal with.

The James-Lange Theory of Emotions

Since James and Lange did not distinguish between feelings and emotions their theory is presumed to apply to both. In addition therefore to the corrections that we have discussed in the James-Lange theory of feelings, there are some comments that must be made when the theory is applied to emotions. Here the question is how to interpret the details that we observe during the emotional situation.

We suggest that what James calls the psychic state, which succeeds the bodily activity, merely constitutes another behavior segment. As a matter of fact, James is here confusing what he calls the psychic state with the second post-emotional behavior segment. What James means by this psychic state which succeeds the bodily action is really the activity of reflecting upon one's good fortune in escaping from the danger.

Furthermore, what James calls the bodily activity really constitutes the emotional behavior-segment proper. And what he calls the bodily features of emotion that immediately follow upon the perception of the dangerous object are the organic reflexes which replace the response which fails to occur. This takes care of his description of the trembling, blanching, and other similar features of the situation. Then when he refers to the running, he undoubtedly is pointing to the first post-emotional behavior segment in which a new stimulus elicits the reaction described. And finally, as we have indicated, the realization of what has happened, which James refers to as the consciousness of fear, is the second post-emotional behavior segment.

Experiments on Emotions

Since psychologists generally do not distinguish between feelings and emotions, and since the former are so much more easily induced under controlled conditions, there are really few actual

laboratory studies of emotions available. Such studies as have been made show the kind and intensity of organic action, demonstrate that there are no unique physiological changes involved in specific kinds of interactions, and that the so-called facial expressions of emotions are merely conventional ways of regarding such action.

CHAPTER XV

REMEMBERING, FORGETTING, AND REMINISCING

Remembering, a Tri-Phase Behavior Segment

You ask me to meet you at the club tomorrow at two o'clock. If I agree to do so and appear at the appointed place at the specified time I am performing a memorial action. My failure to do so is an act of forgetting.

Now let us examine this behavior and analyze out its characteristic features. At once we notice that memorial conduct involves an integrated time element. Although we may have in this particular illustration as many as twenty-four hours intervening between the beginning and the end of the response, the whole time interval constitutes a single unit. A memorial interaction necessitates therefore a delayed response. A delay of how long? It depends upon the particular situation. Each memorial action constitutes a distinct form of adjustment and in consequence the interval of delay varies with the implicated circumstances.

The fact that a memorial action requires delay points to a very significant feature of memory. Above all, memorial behavior is a forward looking action. It is an act that once begun cannot be completed until some future time. This is probably the most characteristic of all the features of remembering. It is strange, therefore, that psychologists generally overlook this point and invariably regard memory as having a backward reference.

It is hardly necessary to add that the making of an agreement as in our illustration is not an essential factor in remembering. It is only necessary when I am asked to do something. When the action is initiated by some other stimulus than another person's request, there is no agreeing act in the situation.

We may summarize our description of remembering behavior by saying that it is an interaction involving a response which is

initiated at some particular time and not completed until some future period. When I perform a memorial response I project an act into the future in the sense of delaying its completion until a later time. The memorial behavior segment then consists of three phases—namely, (1) the initiation phase, (2) the delay or waiting period, and (3) the consummatory or final action.

How the Memorial Behavior Segment Operates

THE INITIATION PHASE.—How can we project an action into the future? What is the process of delaying a response? If these processes are actual psychological facts, there must be some specific behavior which constitutes the beginning of a remembering response. To start a remembering activity means to organize certain stimulus and response factors. How can I make sure that I will meet you at the club tomorrow at two o'clock? Notice that at the appointed time I must be stimulated to do something, but your request cannot be the stimulus, since that event occurred some time ago. Obviously there must be some substitute stimulus to elicit my act of keeping the engagement. As a matter of fact what I do is to make a note of the engagement in the memorandum book or on the calendar which I constantly consult.

Projecting a reaction into the future or delaying an action is essentially this process of interconnecting a substitute stimulus with the original stimulus and the action to be performed. That the notation on the calendar or in the memorandum book is the substitute stimulus for the consummatory memorial reaction is demonstrated by the fact that if for some reason I do not look at the notation, then my act is one of forgetting rather than remembering.

This memorandum form of projecting an action is but one of many possible types. If, for example, the engagement is of importance to me, and if my days are well organized, my projection of a future action consists merely of fitting this activity into some vacant period. The vacancy of the period itself serves as the substitute stimulus for the consummatory phase of the memorial behavior segment.

Are all projecting acts such deliberate behavior as our illustrations indicate? The answer is, of course, no. Though we have chosen for our examples the most definite way of initiating memorial behavior there are other forms. For instance, a person is

determined to listen in on the radio at some future hour, simply by hearing the announcement of an interesting program.

THE DELAY PERIOD.—It would be no effective response on my part if I repaired to an appointed tryst before the proper time. It is for this reason that we must regard the delay period as a distinctive, integral feature of the memorial behavior segment, even though waiting may not superficially seem to be an action.

Likewise we would note that the delay period is not always and entirely bereft of action relevant to the consummation of the remembering adjustment. Very frequently if the engagement is an important one this delay period is partially filled with anticipatory performances of the final act, which often make it impossible to forget to perform the projected reaction. If the student is requested to appear at the Dean's office at a certain time, he constantly reinforces the connection of the substitute stimulus (whatever it may be) with the consummatory act by saying over to himself, "See the Dean, two o'clock Friday," or at least "thinking" it.

THE CONSUMMATORY PHASE.—This part of the memorial response consists merely of performing the projected or delayed reaction when stimulated by the substitute stimulus. We might ask what kind of substitute stimulus is most effective? In many instances formal substitute stimuli like memorandum notes or calendar marks are the most efficacious. This is not, however, always the case. In the first place, we might not even come across such reliable aids to memory. Again, when we do rely upon the help of such formal substitute stimuli we become less sensitive to informal stimuli. Can the lover ever forget to meet his beloved at the trysting place? Almost every object or situation becomes a potential substitute stimulus for carrying out the tryst. How is such a congeries of informal substitute stimuli possible? The answer is plain. Under ordinary circumstances the various phases of an individual's reactional life are all systematically organized and interrelated with the various persons and objects constituting his human environment. It is this kind of interconnection of the person with his surroundings that often makes it impossible for the consummatory phase of a memorial behavior segment not to operate.

Informational and Performative Memory

For illustrations so far we have used performative actions. We call memorial behavior performative when the individual projects

some response such as meeting a friend or posting a letter. But this is only one kind of memory.

We may also project informational responses. In making his plea at the trial the lawyer will require certain knowledge. Accordingly, by means of his memoranda he projects this material to such a time as he desires to be reminded of it. This exemplifies the informational type of remembering. Another illustration is afforded by the person who means to scintillate at an approaching dinner party. He therefore looks up certain information in the encyclopedia to be recited at the proper moment.

The majority of our memorial responses in complex behavior situations are probably combinations of both the performative and informational types. Thus even in the ordinary situation of making an engagement I remember that I have agreed to go to a certain place, as well as remember to go. When I remember and don't forget, the substitute stimulus arouses the act of knowing what is to be done as well as stimulates me to carry out this performance. Incidentally the memorial behavior segment is consummated when I know at the proper time that I must go to a certain place, even if I forbear the going.

Definite and Indefinite Memory

Although memorial response patterns constitute unified and continuous temporal behavior events they are not all as definite as our illustration, in which acts are projected and promptly carried out. Sometimes the adjustment stimuli are not so definitely localizable in place and time. In such cases the projection cannot be very definitely made. In consequence certain memorial acts must be initiated without definitely determined moments of consummation. We cite two such indefinite situations.

Simple Indefinite Memory.—College life with its constant threat of examinations imposes upon the student the necessity of projecting verbal responses into the future. Now since he does not know just when the quiz will present him with the stimulus for the completion of the response we must regard such memorial behavior segments as indefinite.

Hypothetical Memory.—The eager candidate prepares for the interview with his prospective employer by anticipating the conversation. Should the employer make such and such inquiries

the job hunter must reply with a previously worked out and projected answer. Technically speaking, the possible future question is selected as a hypothetical substitute stimulus for the consummation of a certain memorial response. The indefiniteness of this type of memorial action can be estimated on the basis of the probability that the question will or will not be asked. The extreme case is that in which the response pattern remains incomplete, as when the projected act is never performed.

Why We Forget

We never remember anything without the danger of forgetting. The possibility of failing to complete a pattern of response of which part must be postponed is inherent in all commerce with the future. The cause of our forgetting may lie either in the way we project our behavior or in the conditions surrounding the consummation of a memorial act.

The best way to avoid forgetting is, of course, to connect up tightly our consummatory responses with as many substitute stimuli as the situation seems to warrant. Many an engagement has not been kept because the individual concerned did not take into account that his secretary, who served as the sole substitute stimulus, might some time be ill. But even when we connect our action with many substitute stimuli there is always the possibility that we may not come into contact with them. It is true that this possibility is very slight in an extremely important memorial situation (such as the love tryst) but it may happen even here. Any circumstance which disconnects us from our substitute stimulus will cause us to forget. What are some of these circumstances?

Preoccupation interferes greatly with our memorial conduct. To be absorbed in some task at a time when we should be sensitive to the presence of substitute stimuli for some memorial behavior means almost inevitably that we will forget.

Moving out of range of substitute stimuli is another potent source of forgetting. We can become detached from substitute stimuli by mislaying our memoranda. To go out of town means that the objects and persons which usually serve to remind us of our projected engagements will be precluded from affecting us.

It is well known that the *grieving* and *depressed* individual is generally withdrawn from his stimulational environment. Accord-

ingly while one is undergoing such feeling experiences, especially if they are intense, one cannot be very well depended upon to remember anything.

Memory and Memorization

Remembering is very different from memorizing. And yet they are often confused. The cause of this lies no doubt in the conventional way of describing the memorization form of learning.

Memorization is invariably defined as a process involving three stages. First, there is the acquisition or learning of an action, secondly, its retention, and thirdly, its recall. It is probably the superficial resemblance of these three phases to those of a remembering action that has led psychologists to regard remembering and memorizing as identical.

We suggest that greater differences can hardly exist than between these two psychological interactions. As we have seen, any memorial performance is an activity that occurs but once in the life time of the person. Never again will I remember to meet "X" at the club at eight o'clock p. m., August 15, 1928.[1] Each instance of remembering is a unique adjustment to a particular event. It is for this reason very different in each phase from a memorization activity.

Acquiring behavior, which is the first stage of memorizing, is a very different thing from projecting an action. When we memorize we keep repeating some sort of verbal action whether nonsense syllables, or verses, until we are able to recite them. (Such learning is essentially a process of acquiring a capacity for performing certain kinds of action.) This contrasts markedly with the process of postponing an action which we are thoroughly able to do already.

The non-performative period in memorization is merely a fact of not being in contact with a stimulus in connection with which the act was acquired. It is in no sense waiting to carry out an action that requires a definite time period for completion. When the person is stimulated to perform the action it is another behavior event altogether. Moreover, when the stimulus comes it is the direct stimulus for eliciting a reperformance of a certain

[1] Although I shall probably never "forget" that I once performed or failed to perform that action. This means that I may frequently reminisce about this event.

act, and not the substitute stimulus for the completion of a memorial reaction pattern which is performed but once.

The contrast between memorizing and memory is just as great in the third stage. Whereas in the memory situation the person is consummating a continuous though suspended action, in the case of memorizing the individual merely exhibits his accomplishments, or exercises a capacity he has developed.

Memory Involving Memorizing. Memory and memorizing can be easily distinguished when the two are involved in the same behavior situation. It is an unfortunate circumstance that a great amount of studentship consists of performing memory reactions in conjunction with memorizing. Cramming for examinations illustrates such behavior. Cramming consists essentially of projecting to the examination period certain memorized statements. To memorize a speech for delivery at some definite time and place is another example of combining these two different kinds of behavior. Projecting the speaking action to eight o'clock Friday evening, University Hall, is true memory behavior. Learning the speech by reciting it over and over is, of course, merely memorizing.

Remembering versus Reminiscing

Remembering must also be distinguished from reminiscence. The latter, though often performed in connection with memorial conduct, is quite a different form of behavior. Reminiscing is simply the type of implicit behavior by which we respond to past events. It is essentially the reliving of some previous experience. Unlike the forward reference of remembering, reminiscence invariably looks backward in time. Quite often our reminiscences comprise the verbal recital or description of some kind of experience in which we have had a part. In other cases the reminiscence takes place in terms of imagery. We pass in review a series of past events. There are at least three distinct forms of reminiscence, all of which emphasize the difference between such behavior and remembering.

Casual Reminiscence.—In this type of implicit action the person is passive and merely reviews past events. In everyday language, trains of ideas pass through his mind. Sometimes this activity is indulged in for the pleasure it affords us. In other cases we are "haunted" by some circumstance, some work we have

left undone, or some error we have made. Still other actions of casual reminiscence occur simply as the filling in of vacant periods of time.

When we sit relaxed before the fire we hear again the words we were so pleased to have heard; we enjoy anew the swish of cooling water against the alders on our last fishing trip; we "feel" the pull of the trout upon our line. This is a typical form of pleasurable reminiscence or revery.

The "haunting" form of casual reminiscence requires no further elaboration. The time-filling type is also familiar. Some obscure and unimportant stimulus may start off an implicit reaction to some past event, after which we continue to react in this manner until we are stimulated by some object to snap out of our revery. Once we start on this form of behavior the preceding response itself stimulates another reaction as a link in a long chain.

Determined Recollection.—The witness in a court trial is compelled to go back in his past experience to tell what happened in a certain situation. He must "recall," that is to say, he must know exactly whether A's car struck B's or vice versa. This is again a case of implicitly living over a past experience but with strict limitation as set by the present courtroom proceedings.

There is another form of determined recollection that perhaps even more fully justifies the expression "reliving" an experience, which otherwise is hardly more than a figure of speech. This is the case of going over the entire ground covered yesterday on the golf links in search for the pen-knife lost during a strenuous tournament. This type of behavior is the means then of accomplishing some necessary and indicated purpose.

Memorial Recovery.—Here is another kind of reminiscence the performance of which itself has a practical value. In recent years the practitioners of medical psychoanalysis have made strong claims that they have been able to cure patients suffering from various neuroses by having them live over past experiences related to their present abnormalities. This form of reminiscence is the same in principle as religious confession, in which one eases one's conscience with respect to some supernatural power.

Autonomous and Dependent Memory

Ordinarily our remembering behavior segments are indissolubly interconnected with other types. For the most part I project reac-

tions into the future primarily for the purpose of doing something else. For instance, I project an informational reaction so that I can tell my friend something that I think he needs to be told. I put a note in my memorandum book so I can give my colleague a bit of information that I have come across and which he needs for the book he is writing. Such acts of remembering are performed as subsidiary to other actions—to be helpful to some one.

But in other cases my memorial behavior is quite independent of my other action. There is an article to be read or some task to be performed which I have no time to do now. I therefore postpone or delay the act until some free moment that I can definitely anticipate.

Individual Differences in Memory

The famous "theft" of a musical composition by the young Mozart[2] excellently illustrates individual differences in projecting behavior. It appears that the Miserere of Allegri was so highly esteemed by the authorities of the Sistine Chapel that they prohibited the chapel musicians, under pain of excommunication, to take any part of it away, to copy it themselves, or permit anyone else to do so. However, Mozart was able by going to hear it once to project a transcription of the composition. He required only to hear it a second time in order to complete and correct it. This behavior of Mozart's certainly exemplifies a remarkable feat of remembering, although the total activity also involved some reminiscent performance.

Why do some people remember better than others? Why are some individuals more to be relied upon to keep engagements? Since remembering is not a faculty of some sort, but a way in which persons interact with objects and situations, we must look to such interactional sources for our answer. Moreover, since remembering consists in postponing or delaying an action it is in the projection of behavior that individuals really differ.

Some persons can judge better than others which substitute stimuli are likely to prove effective. Also, those who are more familiar with the things to be remembered or the general circumstances surrounding the behavior in question have a decided advantage. We may conclude, then, that general intelligence or

[2] See The Life of Mozart, by Edward Holmes (Everyman ed.), p. 53.

broadness of information is a factor in memorial individual differences.

Differences in habits also may condition the relative superiority and inferiority in performing memorial activities. Persons who are in the habit of using memorandum books, or whose behavior lives are organized into regular habits, are more prone to show a greater balance of remembering than forgetting.

Can Our Memorial Behavior be Improved?

For the most part psychologists answer this question in the negative, since they regard memory as a faculty of retention. Translating the faculty into neural terms they think of memory as a capacity the nervous system has for retention. Furthermore, they regard the different nervous systems of individuals as possessing this faculty in different degrees. Accordingly they assume that any particular person's memory is not capable of being improved. Only the way this faculty is used can be trained.

Since it is admitted that we can improve our memory performances, the assertion that there is a fixed memorial faculty is beside the point. Whether or not we accept such a faculty makes no difference in the description of memorial conduct. There is, however, a distinct advantage in the view that remembering is a specific form of interaction with things. When we regard remembering as a process of projecting acts into the future by connecting them with substitute stimuli, we are able to locate the means of improving any person's memorial behavior. What is required is the discovery of the concrete details of an individual's behavior life in connection with the particular objects and situations to which he must react.

Abnormalities of Memory

Sometimes to forget is the most normal of occurrences, but to do so constantly and consistently, if only for a certain period, is abnormal. Probably the most outstanding abnormality of memory occurs when one fails to perform any activity postponed to a later time. We may regard such a condition as a general inability properly to project responses.

Less comprehensive abnormalities of memory are those in which persons fail to perform particular kinds of activities. A doctor

reports that he is simply unable to keep an engagement with an uninteresting patient. Another illustration is the case of the doctor forgetting to go to his free clinics. Unpleasant behavior is difficult to carry out even when we are able to project it. All of these failures of memory are exaggerations of forgetting in everyday life.

Such disturbances of memory behavior occur, of course, only under definite conditions of crisis and shock. It is only natural, then, that one's exaggerated memorial behavior is part of a general behavior disturbance. Abnormal memory behavior is always connected, among other response conditions, with abnormalities of reminiscence. What is called amnesia or abnormal memory is for the most part not the failure to perform postponed action but the permanent or temporary dropping out of certain types of action from one's behavior equipment.

CHAPTER XVI

LEARNING INTERACTIONS

Learning Essential for Psychological Adaptation

The primary occupation of the psychological organism is to adapt itself to its surroundings. In the case of the human individual this means not only adjusting to things as they are, but also to a certain extent reconstructing his environment to suit his needs and aspirations. The performance of this adjustmental behavior does not come ready made to the person. He must develop behavior for this purpose. It follows then that a great part of the reactional biography of every human being must be devoted to learning.

In the earliest days of the organism, as it comes into contact with surrounding objects and conditions, elementary biological coordination must be developed. The infant must learn to sit, stand, control itself, and manipulate things.

When childhood is reached, the individual must learn to walk, talk, to avoid harmful objects, and to make things. In this period he must develop an elaborate acquaintance with things. This acquaintance with the surrounding world constitutes the knowledge which is so important a part of human existence. At this stage, too, the child is no less occupied with acquiring all sorts of behavior techniques or skills.

As the child matures he must inevitably learn to adapt himself to an infinitude of social conditions. He must become familiar with the laws and conventions of his society. He must eat in a certain manner, speak gently and truthfully; he must wear certain types of clothing, and keep them neat. Things that belong to others must not be appropriated nor destroyed.

With the advancement of years comes the problem of work. The individual must acquire a trade or profession. This means the development of the capacity to build buildings, operate machines, paint pictures, cure disease, or plead in court. Further-

more, he must acquaint himself with the history of his society and how it compares with other human groups. He is also required to know something about the economic world and how to care for his general welfare and that of others. In sum, the human organism must learn all sorts of skills, abilities, knowledge, and capacities.

Learning Not Synonymous with Reactional Biography

Although learning forms a very large part of every person's reactional biography the mistake must not be made of regarding the two as synonymous. Reactional biography includes, besides learning, casual S$\longleftrightarrow$R coordinations. In short, it is the complete record of psychological performance.

Learning is not Sheer Behavior Acquisition

No more may we identify learning and behavior acquisition. Some learning does not involve behavior acquisition, and some behavior acquisition requires no learning. All forms of reaction must be acquired or developed, but many of these acquisitions can hardly be called learning.[1] For instance, here is a child who has developed a distaste for milk, or another infant who calls an automobile an "agawanny." In what sense have these reactions been learned? It is perhaps only by defining learning as acquisition that we can regard these behavior developments as learning.

On the other land, learning need not involve any new acquisition of behavior equipment. It may merely consist of performing an already acquired action in a particular way. Thus when the child learns to refrain from speaking in the presence of older persons until he is first spoken to, he becomes polite but does not develop any new reactions.

We conclude therefore that while much learning does, of course, involve behavior acquisition, the latter is not an absolute factor.

Learning is Contrived Stimulus and Response Coordination

Learning may be defined therefore as contrived stimulus-response coordination. Such coordinations, whether or not they involve behavior acquisition, are in some sense determined by cir-

[1] Attention is called to the fact that the conception that all behavior acquisition is learning was developed in order to differentiate between acquired (learned) and unacquired (native) performances.

cumstances other than the chance or accidental contact of the organism with things. Learning involves special behavior conditions, which we may regard as controls of the learning behavior.

Among such controls we mention first some sort of goal set up by the person himself, or dictated or prescribed by someone else. In consequence, when reactions are to be acquired their kind and number are determined in advance.

Observe how the child learns to read. Notice how the stimulating material is brought into contact with him. The characteristics of the letters, words, and sentences, and their relation with the things they represent are pointed out to the child in order to help him learn them.

In the earliest life of the individual such contrived stimulus-response coordination occurs under the behavior auspices of the family milieu. Parents and nurses demand that infants and children learn to control their excretions, avoid dangerous objects, and refrain from destroying the family possessions.

Somewhat later in life the contrivances are worked out under school auspices. At this period teachers constitute the agents of family, and society in general, for bringing children into contact with informational and other types of things with which they must learn to interact.

Another form of learning control may be traced to the necessities of either one's natural or human surroundings. The need to move a heavy stone may lead to the learning of the physical principles of a lever in a more effective way than by having them explained. Again, it is the necessity of human association that makes us develop speech reactions. In a similar way society prescribes that we learn innumerable items of knowledge, skills, and social performance.

But the contrivances of learning are not limited to the setting up of goals or ends. The specific techniques of learning also constitute definite controls or contrivances of behavior acquisition. An example of such techniques are practices of all kinds. We cannot even mention many forms of learning, such as piano playing and typewriting, without thinking of the great amount of practice that is necessary. Practice is required to strengthen the $S \longleftrightarrow R$ coordination. This strengthening of the $S \longleftrightarrow R$ connection, besides determining how well one has learned, decides the question whether there has been any learning at all. In addi-

tion there are certain contrivances involved in the arrangement of optimal conditions, such as the spacing of practices and other essential mechanisms of learning.

For children most of these techniques are contrived by others. Mature individuals must themselves devise all sorts of situations for deliberately coordinating stimulus functions and responses. Every student, for example, finds it expedient to work out necessary arrangements to facilitate his acquisition of the materials and processes of scholarship.

Various Forms of Stimulus-Response Coordination

Learning as a psychological process consists primarily of connecting responses with the stimulus functions of objects. Learning therefore is the organization of behavior segments under various contrived conditions. Naturally these various behavior segments are organized in different ways.

Original Stimulus-Response Connection.—One of the most fundamental types of learning is the connection of a completely new action with a new stimulus function. This kind of learning occurs when the individual comes into contact with objects for the first time. In learning to read the child develops verbal responses which are afterwards always elicited by printed words which only recently were entirely new to him. Here is the process in its simplicity. Of course, when we say a completely new action we do not mean to deny that it is an organization of simpler component acts which the child had previously acquired. The action must be regarded as new because it is part of a new adaptation.

Transfer Learning.—The transfer type of learning is exemplified by a puzzle box experiment. The task is to get the door opened by turning a handle in a certain way. After the individual coordinates the proper response with the stimulus object the situation is complicated by disconnecting the opening mechanism and attaching it to another handle added to the box. The learning here consists essentially of transferring the stimulus function for manipulating the mechanism from the first to the second handle. When the learning is complete the first handle loses its stimulus function altogether.

Another form of puzzle box illustration is that in which the organism must step upon two levers in the order a-b, as a means of getting out of the box. We regard it as a transfer form of learning when the animal learns that the proper stimulus function lies precisely in reversing the order to b-a.

CONDITIONED LEARNING.—The famous conditioned response experiment exemplifies a distinct type of learning. The behavior change consists in coordinating a response whose stimulus function originally inhered in the meat with another stimulus function residing in the sound of a bell. To obtain this effect the experimenter must arrange a suitable connection of contacts between the organism and the two stimulus objects.

The reader must be warned, however, that psychologists generally use the term conditioning for transfer learning also. The difference between transfer and conditioned learning is that in the former case the emphasis is upon the endowing of a new object with an old stimulus function taken away from some other object, while in the latter case another object is also endowed with the same stimulus function in addition to the old object which retains its stimulating capacity.

Another good example of conditioned learning. In America the young man learns to tip his hat to women. Now when he goes to Germany he modifies his behavior so that he tips his hat to men also. In terms of stimulus-response coordination what happens in the present learning situation is that the stimulus function calling out a certain response is made to inhere in an additional object.

When the child discovers that this other little boy is likewise called Harry he undergoes a similar form of learning experience. The stimulus function of calling out the name response Harry is also invested in the other boy.

SUBSTITUTION LEARNING.—Whenever we rectify some form of wrong behavior we really substitute responses by building up a new stimulus-response coordination to replace the undesirable one. And so what appears on the surface as the elimination of a reaction, a process frequently referred to as negative learning, is really a phenomenon of substitution.

Consider once more the classic child and candle illustration. When the child substitutes the response of holding his hand still, or in other words not permitting it to touch the candle flame, we

have a new coordination of this response, substituted for the old touching response, and a new function located in the old object with which the child has already had contact. The question arises whether there is ever any sheer elimination of stimulus-response connections. If not, the term negative learning can only mean a substitution of stimulus-response coordinations. From the standpoint of general conduct a form of behavior has been eliminated, but the detailed psychological processes must be taken into account. There is no question that from a psychological standpoint we have here just as positive a learning event as in any other situation.

The substitution type of learning is of great interest because of its employment in treating children's problems. Here is a child who refuses to eat raspberry jam. At some past time there has been built up a reaction of dislike with respect to this food. In general terms, the problem here is to eliminate this stimulus-response coordination. The specific psychological process is really the substitution of a liking for a disliking reaction and endowing the food with a stimulus function that will call out the liking response.

The substitution technique must be resorted to frequently with some children. In each case a specific contrivance must be used. Sometimes it is sufficient merely to point out how another child eats raspberry jam with great enjoyment. In other instances some sort of reward must be offered. The writer has recently observed a striking case of such substitution. At first the child virtually abhorred the sight of the jam and in a few weeks persisted in eating it with greedy delight.

Some interesting substitution work has been done on eliminating fear reactions.[2] For example, Mrs. Jones, working with Watson, cites the case of a small boy who was afraid of a rabbit. At first he could not tolerate the rabbit's presence even when it was caged, though he finally learned to fondle it and let it nibble his fingers. In this work the contrivance consisted of employing what we may regard as a catalytic agent. The rabbit was brought closer and closer to the child while he was eating some food that he liked. Gradually the fear stimulus function and action were substituted for by a play stimulus and response.

Additive Learning.—A very simple learning principle is that of developing series of stimulus-response coordinations in the same

[2] M. C. Jones, Elimination of children's fears, *J. Exp. Psych.*, 1924, 7, 382-390; A laboratory study of fear, *Ped. Sem.*, 1924, 31, 308-315.

object. An individual learns the name of a thing. After further interactions with it he learns its properties. Thus when occasion demands he is stimulated by this object to use it for some purpose. Because the person interacts in all these various ways with the same object we speak of the learning as an additive process of new stimulus-response coordinations. This is probably the most common form of learning situation in human life.

Combination Learning.—Complex learning situations may involve several forms of stimulus-response coordinations. Notice the behavior of the instructor in the early days of a course as he tries to learn the names of the members of the class. For some reason he coordinates the name-response Mr. Hill with Mr. Smith, and vice versa. When he begins to call upon the students to recite he discovers that he must transfer the stimulus function of calling out the name Hill from Mr. Smith to Mr. Hill, and the stimulus function of calling out the verbal reaction Mr. Smith from Mr. Hill to Mr. Smith.

But we find here also the elimination of the reaction Hill to Smith and vice versa, so the learning involves besides transfer also substitution. Furthermore, when the instructor finds that two persons answer to the name Smith, he conditions his learning response by coordinating it with another stimulus function residing in the other Smith.

Perfect and Imperfect Learning

Whether or not learning serves as an efficient form of psychological adaptation depends upon its perfection. When I learn to shoot it is necessary to do more than aim at a target. I must hit the center. This means that learning involves besides the mere $S \longleftrightarrow R$ coordination some supplementary behavior changes.

In the first place, the connection must be strong. Not until we can be sure that the stimulus will call out its coordinated responses is the learning perfected. In other words, a habit must be formed. The child has not learned its multiplication table until the stimulus three times four of necessity calls out the response twelve.

Perfect learning means therefore habit development. Habits are essentially integrated connections of stimuli and responses. When such habits are formed we may expect satisfactory adaptational behavior.

Such a strengthening or integrating of a stimulus and response brings in its train various marks of perfect learning. In the first place, firmly to connect stimuli and responses means that the learning is fairly permanent. The individual always performs the necessary behavior when called upon. By forming habits he becomes dependable.

The inevitability of habitual reactions is emphasized when undesirable behavior connections are made. Everyone knows how difficult it is to overcome a bad habit. When the wrong response is strongly integrated with a stimulus there is great difficulty in breaking the connection. Inerrantly to perform a wrong reaction is quite a detriment to one's social adjustments.

In the second place, when the connection is fixed the individual is also prompt in his behavior. When we develop habits we can be depended upon to respond immediately to particular stimuli.

Furthermore, to integrate stimuli and responses closely means to perform responses accurately. When we practice sufficiently so as to connect a certain response with a stimulus function closely we may expect to achieve a satisfactory performance.

In considering the accuracy of habitual behavior we discover that it depends upon building up stable and steady performances. We cannot become expert in archery or rifle shooting until we learn to hold ourselves solidly and grasp our weapon with a firm and steady grip.

How perfectly we should learn anything depends upon the kind of adaptational situation. Many actions we learn for use in certain temporary circumstances. We learn certain games to please our hosts or guests, and the social obligations over, we do not play again. For such situations a very imperfect learning may suffice.

Furthermore, perfect or habitual learning is only available for more or less routine situations. Complex and important learning must always be open to the irregularities and inaccuracies that can be eliminated from simple learning circumstances. Habitual learning pertains to skill and rote memorization, but does not apply to the study of ideas. This distinction suggests the separation of rote from logical learning.

Logical versus Rote Learning

The life of a student as far as learning is concerned can be divided into two parts. On the one hand, he is required to acquire

a series of responses which he must be able to perform whenever he is called upon to do so. The child must memorize the multiplication table, the names of capitals, and the presidents of the United States. It is therefore to his advantage to acquire the capacity for performing this sort of memorization behavior. In this connection the individual may profit by the various experimental results in the economizing of rote learning.

On the other hand, it is to be hoped at least that even children in the elementary schools are required to alternate this rote learning with logical learning. They should be trained in the methods of associating and organizing facts on the basis of the natural and logical order of things. Certainly this should be the primary type of learning in higher schools. For this reason the acquisition of the technique of logical learning is an aid in the field of learning in general.

To indicate more sharply the nature of logical learning, suppose the question arises concerning some presidential administration. Instead of having merely associated the name with a number, such that Jefferson was the third president, logical learning demands that the student work out the relationship between (1) various conditions existing at the time of Jefferson's and Washington's administrations, and (2) the relationship between American and other nations, such as the Spanish, French, etc. Probably the differences between the two learning methods and their service in the general work of learning are best shown by the evil results in overemphasizing the rote method. Every educator is acquainted with the undesirable consequences involved. The best, because the most horrible, example is the student whose whole learning time, and effort are devoted to acquiring merely verbal responses to various sorts of learning stimuli. Instead of understanding the nature of a certain phenomenon and its relations to other things, he has only a set of more or less ready verbal answers to questions concerning such details.

Reactional Procedures in Learning

Learning is conduct resulting in particular stimulus-response coordinations. But what specific behavior is performed? This depends of course upon the different kinds of learning situations.

IMITATION.—When the child is being taught to pronounce words he is made to repeat an action which the teacher performs until

he is able to do it satisfactorily. This happens when the learner is acquiring an entirely new mode of behavior. "Watch me perform," says the swimming instructor when he is teaching someone else how to coordinate a series of movements in order to accomplish a certain result. In this case the learner copies a model by connecting into a pattern, unit actions which he has previously acquired. The imitative procedure, it may be added, plays its largest role in the learning of skills. Note, however, that imitation operates only when one is learning how an act should be performed, and even then it has an exceedingly limited scope. It does not operate very effectively even in very simple situations. Educators have attempted to teach children to write by putting them through the motions, or by having them draw their pencils through groove outlines of letters and words. The results were not satisfactory. The process of adapting oneself to a situation seems to require more spontaneous behavior than being mechanically put through an action.

OBSERVATION.—Observational learning may be described as a process of ascertaining what is to be done, as in the acquisition of social behavior. Just what one should do is not specified in detail. That honesty is the best policy one may be told or discover for oneself. Now what is honesty? This can be learned by a studied observation of what persons who are called honest do in particular circumstances.

Observing is, of course, not limited to social learning. The entire system of apprenticeship, whether in the mechanical arts, business, law, medicine, or the fine arts, is built upon the process of learning by observation. The apprentice is presumed to acquire in this manner a general stock of behavior equipment that will fit him to adjust himself to similar situations—that is, situations composed of or involving similar circumstances.

TRIAL AND ERROR.—Watch a person trying to learn a puzzle. Observe his interminable manipulations. Trials succeed trials as the inevitable failures signify that the goal has not yet been reached.

Such a trial and error procedure with its apparently random fumbling is characteristic of all situations where some goal must be reached through means that are not readily available. For this reason trial and error appears to be a definite condition in many learning situations. Though final successful learning may at first

seem impossible it does eventuate and in complex situations can only be brought about through a persistent employment of this very trial and error technique.

The trial and error process rests very definitely upon the psychological principle of variability.[3] When the problem is to find the exact means of accomplishing a certain result the individual must bring to bear upon the situation every possible form of available action.

The animal experiment of Thorndike already referred to (Chap. 1) excellently illustrates the trial and error procedure. Fig. 48 shows the kind of cage he employed. The solution of the

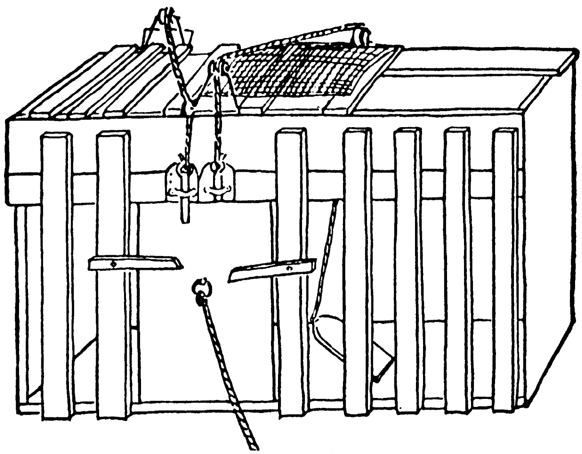


Fig. 48—The problem box used by Thorndike in his experiments on animal learning. From *Animal Intelligence.* Psychological Monographs.

learning problem depends upon the elimination of a large amount of effective behavior so that the succeeding trials with a given animal result in a more speedy exit. When the learning is completed the successful actions are performed at once. Fig. 49 presents a graphic statement of the course of such trial and error learning.

INSIGHT.—Some learning situations require that the organism see into and through the circumstances involved. When the learning procedure includes the definite discovery of relationships and principles of actions we call it insight.

[3] See Chap. 1, p. 8.

Simple forms of insight are illustrated in some experiments which Köhler[4] performed with chimpanzees as subjects. In one of these the experimenter started with an animal that had already learned to use a stick to drag within its reach a banana which was lying outside its cage, and then arranged the following situation. A banana was placed beyond the point where it could be reached by a single stick. The animal was then provided with two sticks one of which could be fitted into the other. The problem was whether the animal would see the relationship between the two sticks, thus providing himself with a tool long enough to reach the desired object. Köhler reports that as a matter of fact after

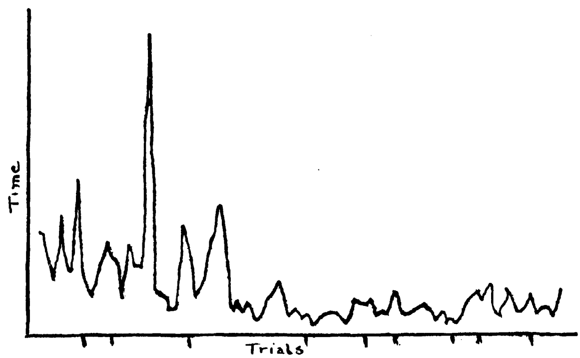


Fig. 49—Learning curve for cat obtained by Thorndike in problem box shown in Fig. 48. The peaks show time required for hitting upon correct responses. The small vertical lines below the abscissa show breaks in experimental periods. From *Animal Intelligence.* Psychological Monographs.

manipulating the two sticks in various ways the animal finally did join them together and obtained the banana. The learning consisted of acquiring a tool-making reaction which could be performed when stimulated by distant objects.

Insight as a process of discovering the means of reaching a goal operates in putting to an end numerous trial and error activities. When the organism can see the relationship between the elements of a problematic situation it can eliminate irrelevant actions. Thus the process of insight can operate along with that of trial and error. Through the random manipulation of things a new arrangement may be brought about. Then the organism may be enabled to see the relation between the new arrangement of things and the goal. In such a case learning is achieved by combining the two procedures.

[4] The Mentality of Apes, Harcourt, Brace, 1925.

How Different Learnings are Related

If a student learns mathematics will this training help him in his study of languages? At one time psychologists answered with a strong affirmative. More recently they have been inclined to just as firm a negative. These answers have been influenced as much by general psychological considerations as by the facts in the case.

The doctrine that training is transferred was based upon the psychological conception that the mind is a substance which can be modified and improved by training. This view was held in spite of the fact that an individual who has studied mathematics long and deeply may be little short of a failure when he comes to take up modern languages.

When the notion became current that the mind consisted of specific ideas in association, psychologists were inclined to give up the doctrine of transfer of training. Yet numerous facts indicate that the more one learns the greater one's capacity to learn. The better trained student of literature can certainly learn more about the subject, and quicker, than one who has not had so good a reactional history for the purpose at hand. This point can be generalized. The more one has learned, that is to say, the more elaborate one's behavior equipment, the better one's chances for acquiring more equipment.

We must conclude that learning can both be and not be transferred. When we study specific learning situations we can easily determine when transfer does or does not occur.

To illustrate, William James measured the time required by himself and several others to memorize selections from poems before and after training with other passages of poetry. The results did not favor the conclusion that memorizing one kind of material helped in memorizing another. Later Thorndike and Woodworth carried on some extensive studies with various kinds of materials and were fortified with this conclusion. The lack of transfer here is to be expected. The learning is very specific and there is little to carry over. In fact, to attempt to learn two kinds of similar material in close order results in interference.

Now, on the other hand, in every large learning situation there are common factors. Thus it is found that in memorizing a list of nonsense syllables every day, by the time fifty have been learned

one has doubled his capacity. In this connection Webb has shown that learning one maze helps in learning another, and in the precise degree in which the mazes are similar. In such a situation the transfer learning and the conditioned learning principles find scope and prove really effective.

Theories of Learning

Psychological writings concerning learning are divisible into two parts. The first consists of the description of facts, while the second is devoted to the theories proposed to explain learning.

Learning theories are of three general kinds. The first we may call the special factor type. Those who propose such theories aim to account for specific items of learning. They do so by selecting one or more features to explain the whole situation. Among such principles are frequency and recency.

The second type of learning theory has for its object the explanation of how an organism can learn altogether. Here the assumption is made that when an organism learns something the learning can be explained by some immediate physiological change which takes place in the individual. The stock theory of this type is the neural synapse doctrine.

Intermediate between these two is the maturation theory which is used to account for both specific items of learning, and learning capacity in general.

Special Factor Theories.—It is often noticed that to reperform an action frequently serves to make that action habitual. Practice or frequence of performance is then called a law of learning. Again, we find that when students like a certain subject they learn it easier or better. In consequence, it is declared that an action is acquired and fixed because it gives satisfaction to the organism. Similar factors that have been made into learning principles are interest and completeness of response.

How can anything be explained in terms of one or more of its parts? This question is just as pertinent in the case of learning as in any other phenomenon. Furthermore the question arises whether any further theory is necessary to explain learning beyond taking into consideration the details of the actual interactions of the organism with the learning material. Certainly frequency, recency, and other factors are merely component features of such interactions and not causes of them.

THE NEURAL SYNAPSE THEORY.—At the basis of this theory is the assumption that when learning goes on, certain connections are formed in the nervous system. During the history of psychology numerous suggestions have been made as to the nature of neural connections, but at the present time the prevalent conception is that during learning the resistance of synapses, the points where neurones connect, is lowered to the passage of neural impulses.

The neural theory, like the special factor theories, explains the whole learning fact in terms of one element. It goes further and violates also the biological facts by attempting to explain the action of the entire organism in terms of particular neural functions. Now as we have seen in Chap. 2, the neural functions are only one or a few of the many factors in a behavior configuration.

That there are anatomical synaptic connections we may accept as a definite fact. But they must be regarded as merely the mechanism for the coordination of the individual's responses. Now we have already seen that learning is never merely the coordination of behavior configurations. To assume that it is, amounts to leaving out of consideration all of the interactions between the organism and the stimulus object. It is highly improbable that learning can be looked upon as merely a phenomenon of neural conduction and integration. Even the biological coordination of responses is not merely the organization of neural patterns. It involves as well the muscular, circulatory, and all the other systems. Certainly then we cannot reduce a complex interaction to a very small part of the response.

The neural theory of learning is based upon the questionable assumption that the nervous system is the seat of the "mind" and therefore a controlling mechanism for the organism's behavior. A specification of this assumption is that certain acts are localized in particular places in the nervous system at particular synapses. An overwhelming series of facts has been recently accumulating to dissipate this localization theory. We can only indicate here that the experiments of Franz, Lashley, Cameron, and others in removing brain tissue make it highly improbable that learning can ever be explained on an exclusively neural basis.[5]

The only significance that the neural theory can have is the suggestion it carries for the differentiation between the learning powers of different species of animals. For example, when one compares

[5] The relevant literature is indicated in the selected references to Chap. 24.

the learning of human animals with subhuman forms, one finds some correlation between the more complicated actions and more complex nervous systems of the human organism as over against the simpler actions and simpler nervous systems of the subhuman animal. But even here there is a fallacy in overlooking the general differences in all other tissues and organs as well as in the nervous system in the two types of animals, and also their generally different biological evolutions.

There are still further difficulties with the neural theory when it is used to explain particular cases of learning. This theory turns out to be after all a vague hypothetical suggestion. No one has ever tried to show how any specific learning actions can be accounted for by a particular neural connection. Is there a specific neural connection formed for saying "cat" and for saying "dog"? That learning can hardly be explained as neural connections is evidenced by the fact that in psychological performance we really are not dealing with neural connection.

Lashley[6] writes that he began his studies of cerebral function with a definite bias toward the conception of learning as the development of conditioned-reflex arcs or restricted conduction paths in the cortex of the brain, but that the experimental findings have never fitted into such a scheme.

Two of the many experiments may be cited that indicate the insufficiency of a neural theory of learning. First is Lashley's destruction of both visual areas in a rat, the left eye of which he blindfolded while it learned a simple visual-motor habit. He found that the animal could perform the reaction perfectly when the blind-fold was transferred to the other eye. It appears that the neural connections or synapses involved in the original learning were not responsible for the learning, as they were later not allowed to function.

The second experiment consisted of paralyzing the left arm of a monkey while it was learning a series of complicated latch-box movements with the right arm. After the left arm recovered from the paralysis the animal could open the latch box with it without practice. Apparently synapses of the left arm, which could not have been integrated with the original learning activities, were not necessary for the performance of the actions.

That learning can hardly be explained as neural connections is

6 Brain Mechanisms in Intelligence, Univ. of Chicago Press, 1929, p. 14.

evidenced by the fact that in psychological performance we really are not dealing with simple, fixed neuro-muscular connections. Thus a linguist asserts "that it is impossible for an individual to repeat a given speech movement at will in exactly the same way in which he has previously performed it." He says further that "it may be seriously questioned whether one ever makes the same group of speech movements twice in a lifetime."[7] How can we then explain specific learning situations by hypothetical functional neural connections?

In this connection Lashley points out that if the eye is fixated in a certain position, and a pattern (printed words) moved across the field of vision, the same reaction, for example, naming the word, can be elicited at any one of a thousand points, no two of which involve the excitation of exactly the same retinal cells. He goes on to say[8] that there is a constant flux of stimulation, not only in the retina but in the central projections on the cortex, such that the same cells are rarely, if ever, twice excited by the same stimuli; yet a constant action is produced.

And finally, let us notice that the discussion of neural happenings in learning must always be fitted into the concrete description of the complicated stimulus-response details of psychological interaction. Before we mention neural connections we must always tell (a) what kind of stimulus object is presented. What could make any neural element operate but the stimulus object? (b) The interrelation of one stimulus object with others must also be taken into account. How can neural connections account for the constantly changing response combinations when we utter sentences or more profound speech-response patterns? (c) Description of learning must also specify how often the stimulus is presented, (d) whether there are any distracting or favoring conditions, and (e) whether or not the learner is in good form. It is therefore highly questionable whether learning can be explained as the development of neural connections.

THE MATURATION THEORY.—Was there ever a time when it went unnoticed that an organism must be biologically mature in order to perform certain psychological reactions? Who would

[7] Meader, in Pillsbury and Meader, Psychology of Language, Appleton, 1928, p. 218.

[8] Brain Mechanisms and Intelligence, p. 158.

attempt to teach an infant to run before it could stand up? Curiously enough such elementary observations have been made the basis for a theory of learning. According to the maturation theory psychological learning is merely the unfolding of biological mechanisms. In order to know things the organism has only to grow.

The proponents of the maturation theory confuse complicated psychological actions with the functions of the biological mechanisms. While it is true that in infant behavior the difference between psychological and biological behavior is not so great that maturation is undoubtedly a great factor in learning, even here it is only a necessary condition for, and not a law of, learning. For the mature individual, maturation obviously cannot be even a condition of learning. Unless we make maturation into a mystic learning power we cannot regard it as in any sense a factor in adult learning.

The Limits of Learning

The wide individual differences in learning bring us face to face with the question of learning limits. How shall we account for the fact that A learns much with little effort, while B learns little with great exertion?

In line with the general conception of native capacity it has been proposed that individuals are endowed with certain learning capacities or faculties, and that these capacities differ.

We must declare forthwith that the faculty theory of learning, even when it is connected with brain action, seems out of touch with actual learning facts. If we look upon learning as an absolute capacity independent of learning situations we make of it an utter abstraction unrelated to any actual psychological fact. Such a conception is decidedly of no service to students of psychology.

How then are we to account for the various degrees of learning ability? Frankly, we can see no answer to the question other than that such individual differences as we have indicated must be traced back to the individual's reactional biography. Learning begets learning. Every response acquired constitutes a capacity for further learning. This is true not only of deliberate or contrived stimulus-response coordinations, but of casual contacts with objects also. A person confined to a deserted island will certainly have a tremendously limited learning experience; yet obviously it will be owing to no absolute incapacity to learn on his part, but rather to utter lack of stimulus objects and situations. The only persons

absolutely incapable of learning certain actions are those who are biologically defective or undeveloped. Here, of course, there is no problem of abstract capacity.

How much can a person learn? Is there any limit to learning? Our conclusion is that the actual limits are prescribed only by the human contingencies and circumstances surrounding the learning individual. We are so accustomed to the prescribed limits set by our formal educational institutions that it has become a traditional belief that the child can learn so much and no more, and that to subject him to more learning situations than are popularly accepted as normal, is straining his "mental" capacity. This is sheer myth. There is actually no relationship between what the individual might learn under entirely different circumstances and what he is acquiring at present. In each case, of course, it is necessary to draw our conclusions on the basis of the particular conditions of the specific individual who is learning, rather than on the formal conditions set to his learning.

For the most part it is fair to say that our teaching institutions and instruments are designed for the purpose of adapting individuals to existing situations. Learning activities on this basis consist mainly of acquiring particular techniques of action. We start children off with the mechanics of reading and writing, and then we prescribe certain minimal standards of conventional information. Learning situations are very little if at all devised for the purpose of developing new capacities and growths. Our educational aim has been to adapt the individual to conditions as they are, rather than to stimulate him to attain new and as yet unconventional powers.

CHAPTER XVII

EXPERIMENTAL LEARNING

Typical Laboratory Studies

The experimental organization of a learning situation in the laboratory constitutes the extreme type of contrived behavior. This is true because the experimenter strives to control each detail of the learning process, in order to keep definite records of the learner's behavior. The entire learning situation thus becomes a definite project. First, the material to be learned is prescribed by the experimenter. Then the processes used and the general conditions must be arranged if the desired records are to be available.

On the other hand, just because learning behavior can be so rigidly controlled it constitutes one of the most prolific sources of experimental data. We have already referred to some learning experiments with animals. In addition to these, the literature of psychology discloses a vast amount of work that has been done on the learning of telegraphy, typewriting, ball tossing, archery, mazes, poetry, and other memorization material, along with the learning of language. The following investigations exemplify the experimental learning situation.

Knowledge.—A typical knowledge experiment is illustrated by Swift's study of the Russian language. The investigator, who had never previously looked at a Russian book, spent four half hours on as many days learning the alphabet, and then began to study words. His procedure was to read the lessons in the grammar book for thirty minutes each day and then test his learning immediately for fifteen minutes, to see how many words could be translated.

The curve obtained shows the usual rise, with resting places on the way, and extremely spasmodic periods of improvement. The entire experiment lasted about sixty-five days. These various features of the curve are accounted for by the ease or difficulty of the material and by the conditions under which the learning was measured.

MEMORIZATION.—The memorization work of Ebbinghaus is regarded as a monumental research in experimental learning. This psychologist undertook to learn series of nonsense syllables, some containing as many as thirty-six syllables, like the following: taz, lub, seg, zut. The idea of using nonsense syllables was to eliminate the influence of the meanings of the material in an effort to reduce the experiment to its ultimate memorization character. Ebbinghaus spent five years in studies of this type. Among the problems he set himself (for he served as his own subject) were (1) how much

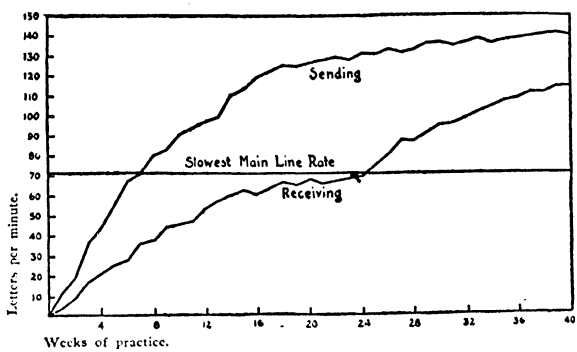


Fig. 50—Curves of telegraphic learning for subject W. J. R. plotted by Bryan and Harter. From Thorndike, *Educational Psychology,* Vol. II, p. 246.

longer does it take to learn a long list than a short one, (2) what is the rate of loss in reciting the lists after different periods of no practice, and (3) can the series be learned only in the forward direction or are other orders also possible?

Since the publication of Ebbinghaus' results in 1885 all kinds of similar memorization studies have been made. The experiments have been varied and improved. Besides using different methods, investigators have dealt with four letter syllables as well as integers, etc.

ACQUISITION OF SKILLS.—One of the first elaborate studies of the acquisition of skills was made by Bryan and Harter on telegraphic language. Students of telegraphy were tested periodically to find out their progress in sending and receiving messages. The measure of learning was taken as the number of letters sent or received per minute. The practice curve of one of the students is given in Fig. 50. It will be noticed that progress was more rapid

at first, with various periods of slowing down, and in the later testings a period was reached when the learning apparently stopped. Observe, too, that the curve for sending rises more rapidly and higher than the receiving one.

The whole process of learning was described by these writers as the gradual building up of a hierarchy of habits. First came the acquisition of letter sending and receiving habits. These were

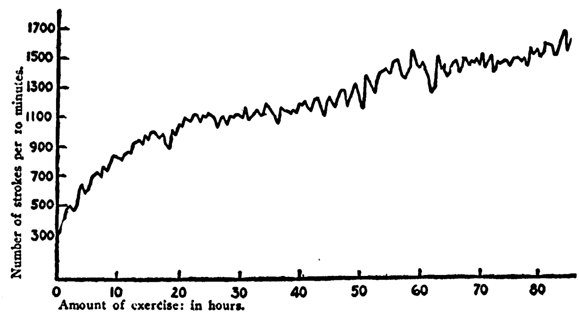


Fig. 51—Curve obtained by Book in his study of typewriting by the touch method. There appears to be a plateau between the 25th and 45th hours. From Thorndike, *Educational Psychology,* Vol. II, p. 138.

integrated into word sending and receiving actions. And finally these word habits were fused into habits of a still higher order—namely, connected discourse, sentences, and phrases.

In actually receiving messages the subjects were found to be responding to phrases and sentences as well as to single letters. This was illustrated by the overlapping observed when a telegrapher transcribed a message. He may type a message and be six or twelve words behind the letters as they are clicked off on the instrument.

It is worth noticing that the hierarchy of learning as it is found in telegraphy and typewriting is the reverse of actual speech development in a child. In speech learning, words and even phrases may be acquired before they are analyzed into letter components.

An experimental study involving many of the same factors is Book's study of typewriting. Here the record was kept in terms of the increased number of correct strokes that were made as the practice period increased. Fig. 51 shows a typical curve for skill acquisition with the resting places and the slowing up at the upper

end. As in the preceding study the learners developed hierarchies of habits.

Other studies of skill that may only be mentioned are the investigation of ball tossing by Swift and Peterson, and archery by Lashley.

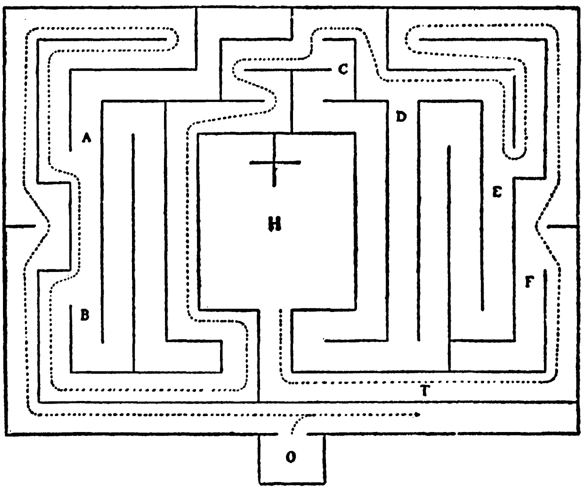


Fig. 52—Specimen of Hampton Court maze. The animal enters at O and must avoid the blind alleys A B D E F in order to traverse the proper pathway indicated by the dotted line and to get the food at H. From Watson, *Behavior,* Holt, publishers.

Maze Learning.—A great number of studies of learning have been made with mazes, both on human and animal subjects. A typical maze is illustrated in Fig. 52. The problem here is to reach the exit in the shortest possible time and with the least number of errors; that is, entrances into the *culs de sac* or blind alleys. Various investigators have gathered numerous data upon this type of learning with all sorts of maze patterns. In many of such studies on animals, punishments and rewards have been employed to facilitate the learning.

Delayed Reaction Experiment.—A very important type of experimental learning is the delayed reaction originally suggested by Carr and worked out by his students, especially Hunter. The experiment involves implicit behavior. In other words, an organism is trained to respond to a stimulus object which has been present,

but has been taken away. The precise situation can be understood by referring to Fig. 53, which shows the apparatus used.

First the animal is trained to go from the release box R across the grid to one of three compartments which can be alternately lighted. The learning is facilitated by charging the grid in front

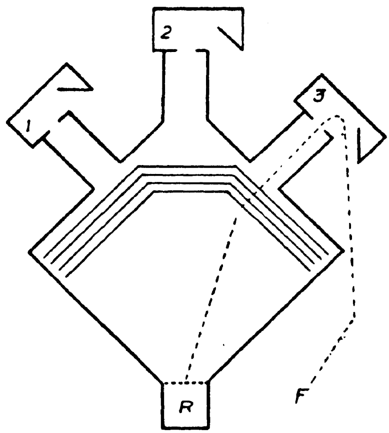


Fig 53—Schematic representation of Hunter's delayed reaction apparatus. R is release box, 1, 2, 3, illuminated compartments, and F feeding station. From Valentine, *Readings in Experimental Psychology,* Harpers, publishers.

of the unlighted compartments; so that if the animal goes to one of them it receives a shock, while if it goes to the lighted compartment, as in following the dotted path to F, it is fed. When the animal has learned this the experimenter turns on a light in either one of the three compartments (to make sure the animal does not react to the place stimulus), turns it off, and then holds the animal for a fixed period to see if it will finally go through the compartment that was lighted. By varying the delay period the experimenter can determine how long the animal can wait and still perform the reaction.

This experiment can be varied in numerous ways and performed with different species of animals. For example, a sound stimulus can be used instead of light. Rats, cats, dogs, raccoons, apes, and children have been used as subjects. In the following table Hunter[1] sums up the maximum period of delay in the various animals.

[1] A table containing other and quite different data is given by Tinklepaugh, *J. Comp. Psych.,* 1928, 8, 197-236.

Rats	1 to 5 seconds
Raccoons	10 to 25 seconds
Cats	16 to 18 seconds
Dogs	1 to 3 minutes
Child 1¼ yrs.	20 seconds
Child 2½ yrs.	50 seconds
Child 5 yrs.	At least 20 minutes
Gorilla	2 to 3 hours

In order to perform delayed reactions, cats, rats, and some dogs must maintain an attitude of orientation with respect to the compartment where the light has been. Other dogs, raccoons, apes, and children need not stand in any particular position. They can move about and still perform the required response at the end of the delay period.

Tinklepaugh has studied the delayed reaction with monkeys under somewhat more natural conditions. This investigator placed two inverted tin cups on the floor in front of a monkey. Then in view of the animal he placed bits of food, banana or lettuce, under one of the cups and then placed a screen in front of the cup. After a period of delay he allowed the animal to go to the cups to see if it would pick up the right one. This it could do even after a period of several hours.

The Learning Curve

To show the results of experimental learning behavior, psychologists employ the learning curve. Learning curves are essentially graphic records of the progress in coordinating stimulus functions and responses. For the most part, curves are plotted by making the horizontal axis or the base of the graph represent the practice period, while the vertical axis represents accuracy, speed of performance, or the amount of material learned.

Curves either rise or decline, depending upon the way the improvement of learning is measured. Thus, in measuring the amount of material learned per unit of time or trial, the curve will rise. This is always the case in memorization experiments. Figs. 50 and 51 illustrate the rising form of curves.

Whenever improvement in speed is recorded the curve will naturally drop. This is illustrated by the maze learning curve in Fig. 54.

When accuracy is plotted against trials the curve may be either an ascending or descending one. For instance, if the accuracy of typewriting is measured in terms of the number of errors made the curve will drop, whereas if the measure is of the number of correct words written with increasing practice the curve will natually ascend.

There is another situation that indicates how the curve depends upon the investigator. To illustrate, if the investigators who made

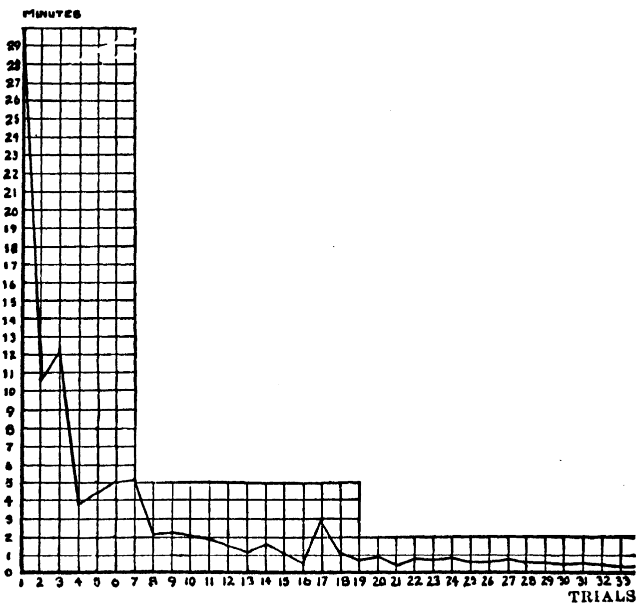


Fig. 54—A learning curve obtained by Watson from 4 rats trained in a Hampton Court maze. From Watson, *Behavior,* Holt, publishers.

the curve in Fig. 50 had plotted it on the basis of how long it took to send or receive a certain number of words, the curve would have descended.

Some kinds of learning can be measured in several ways. Typewriting, telegraphy, and maze learning can be plotted to show either speed or accuracy. This fact gives the investigator an additional leeway in the construction of curves.

Ascending learning curves may be divided into three general types. The first, illustrated by Fig. 50, indicates that improvement

at first is quite rapid and then slows down. This is called a curve of *negative acceleration.*

In some forms of learning the improvement in the earlier part of the practice is slow, but later more rapid progress is made

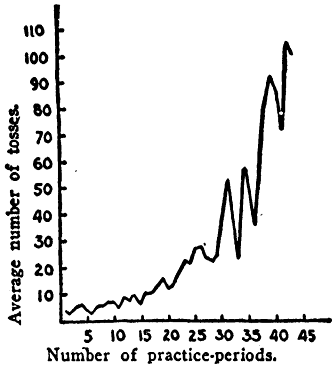


Fig. 55—Ball-tossing curve obtained by Swift. From Thorndike, *Educational Psychology,* Vol. II, p. 120.

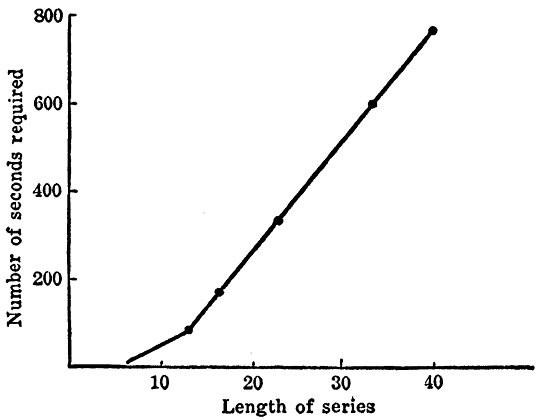


Fig. 56—Curve of uniform improvement. From Rexroad, *General Psychology for College Students,* p. 235, (after Smith and Guthrie). With the permission of The Macmillan Co., publishers.

(Fig. 55). After the improvement begins it increases continuously and gradually. Learning of this kind gives a curve of *positive acceleration.*

In Fig. 56 the curve represented by points equidistant from the x and y axes indicates learning that is constant as the practice periods increase. This is a curve of *uniform improvement.*

It follows then that whether the learning curve descends or ascends is merely a matter of how the learning is recorded and has no importance so far as the essential facts of learning are concerned. The latter facts are involved only in the shape of the curve, which shows whether the learning is uniform, or occurs in the early or later parts of the experimental period.

THE PLATEAU.—In addition to showing that learning increases more at the beginning or end of a training period, learning curves show what is called the plateau. This is a flat region in the curve which represents a period during which the successive practices show very little or no improvement.

Why is there a period of no improvement? Numerous suggestions have been made. One of the earliest has to do with the problem of a hierarchy of habits. Bryan and Harter explained the lack of improvement in receiving sentences by saying that such improvement had to wait upon the fixation of letter and word habits. This suggestion, of course, applies only to this kind of material.

Swift has suggested that the plateau is a period of lack of interest. Individuals are presumed to reach a point at which their enthusiasm lags. Hence their effort is reduced. Book agrees with this in part, but proposes that the plateau also represents a period in which effort is wrongly applied, with the consequent slowing down of improvement.

It has been suggested also that the plateau represents a period of fatigue, although experimental observations indicate that this phenomenon shows itself when fatigue conditions are limited or absent. It is true, however, that plateaus occur only in difficult problems and those that require a long time to complete. Another fact that might argue for the fatigue explanation is that plateaus are more common with some individuals than with others. On the other hand, the fact of individual differences might point to the excluding of fatigue.

As a final sample, the plateau is also attributed to the fact that an ultimate or physiological limit has been reached. While there must be a physiological limit to certain kinds of learning this limit is hardly an explanation of plateaus, which in many cases are readily overcome in later practices. The physiological limit explanation is more effective in accounting for the general nature of a negatively accelerated curve of learning.

Comparison of Normal and Experimental Learning

Learning studies can be devised on two different plans. In the first place, an individual can be observed as he is learning some kind of material while precise records are kept of the activity. The time taken to complete the work, the methods employed, the progress from period to period, and other factors may be rigorously analyzed and studied. The Bryan and Harter study of telegraphy is a good illustration.

On the other hand, the individual can be put into a highly artificial situation and required to learn something far removed from anything he ordinarily does, such as a series of nonsense syllables or lists of arbitrarily chosen integers. Furthermore, in order to control the situation and secure data amenable to statistical handling the number of practices are prescribed and the times they are performed prearranged by the experimenter.

That experimental learning differs from ordinary behavior segment organization is obvious. In the first place, the material is very different. Maze learning is hardly one of our normal adjustments. Also highly controlled learning is exceedingly simple. In our actual learning activities, however, we may have to combine all sorts of responses and even include thinking and reasoning as component activities. Again, even if no complex apparatus is employed in experimental learning, the activity is performed under conditions that are hardly comparable with everyday situations. Especially in artificial learning studies the emphasis is not placed upon how the individual acquires skills or knowledge, but rather what he is able to do under the conditions imposed upon him.

The differences in artificiality between normal and experimental learning situations are revealed in the comparison of results when one memorizes poetry and nonsense syllables. Ebbinghaus compared the learning of selections from Don Juan with nonsense syllables and found that the former material could be learned eight or nine times more effectively. Children given a sentence of thirty-eight words containing seventeen ideas could learn fifteen, while of a series of seven nonsense syllables they could learn only five.

If normal and experimental learning are two entirely different kinds of phenomena can the experimental study of learning throw light upon normal learning? The answer is a stout affirmative. No matter how different the situations, there are certain common ele-

ments. Moreover, the experimental study of learning affords us the only method of obtaining definite data concerning this type of activity.

Conditions of Learning

What makes learning possible? What are the factors that enable some persons to learn easier than others? To answer these questions we must take strict account of the various conditions which we find in learning situations. A fair sample of these conditions would certainly include some of the following:

A. General Conditions

BIOLOGICAL NATURE OF THE ORGANISM.—Whether an animal can learn certain activities depends upon its organization and evolution. Who would expect some of the lower animals to perform the kind of activities that the human animal can? This does not mean that there are no comparable learning situations. In fact, as the accompanying table taken from a paper by Hicks and Carr indicates, there is a great similarity in the maze learning of rats, children, and adults when the circumstances are equalized. But the point here is that only in a few learning situations can the circumstances be equalized.[1a]

A word of warning is necessary. Some psychologists use such results as are indicated in this table as the basis for the inference that the differences in the learning of two persons can likewise be accounted for by biological variations. The student will recognize at once that we have here the same problems that we have discussed in Chap. 4. In other words, it is assumed that in individuals there are different innate capacities for learning, based on biological organization. Howsoever attractive this analogy of reasoning may be, we must not overlook the great jump that is made from differences between species of animals to differences within a single species. We must not confuse the fact that species differences constitute advantages and limitations in animal behavior, with the conception that psychological behavior is a function of biological structure.

NORMALITY OF THE ORGANISM.—It is a matter of common knowledge that in order to do one's best work one must be in good

[1a] During the process of printing this book an important comparative learning study has been published. Cf. W. N., and L. A., Kellogg, The Ape and the Child, McGraw-Hill, 1933.

Comparative Learning of Different Organisms Tabulated in Terms of Average Errors[2] Made in Learning a Maze

(From Hicks and Carr)

Trial No.	Rats (23 animals)	Children (5) (ages 8-13 years)	Adults (4 graduate students)
1	53	35	10
2	45	9	15
3	30	18	5
4	22	11	2
5	11	9	6
6	8	13	4
7	9	6	2
8	4	6	2
9	9	5	1
10	3	5	1
11	4	1	0
12	5	0	1
13	4	1	1
14	4	0	1
15	4	1	1
16	2	0	1
17	1	0	1

health. The undernourished or diseased organism can in no way be fairly compared with a normal individual in the matter of learning capacities.

The same must be said for fatigue. To be physiologically fatigued, no matter what such a condition means in the chemical organization or operation of the organism, means that one is handicapped in carrying out learning activities.

It goes without saying then that mutilations or partial destruction of the organism interferes with learning as well as every other form of psychological action. Thus idiots and imbeciles, representing partially destroyed or undeveloped members of the species, cannot learn as the normal organism is able to do.

REACTIONAL BIOGRAPHY.—Assuming then that we have a kind of organism that is capable of learning a certain kind of activity and further that the organism suffers from no hygienic drawbacks,

[2] By errors are meant entrances into blind alleys, or turning back in pathway. The rats were rewarded by food, while the human subjects were merely rewarded

the obviously important condition for learning is the individual's reactional biography. We say obvious, because as we know an important factor in learning is the general intelligence of the individual; and this factor is a function of the person's reactional biography. Generally speaking, a person who already has a large behavior equipment is a more capable learner than one who has not. Let us see how this works out in a concrete situation. We see demonstrated every day the fact that the student who has previously acquired a fair amount of biological knowledge has a marked advantage over other students while pursuing medical studies.

AGE.—Here is a person about forty years of age. Is it advisable for him to undertake a college education? Psychologists have recently been gradually changing their opinion about this problem. Not so long ago most of them would have declared that such an individual had become psychologically inelastic and could not well profit by a college training.

The basis for the discarded opinion resided in certain superficial observations. It was thought that mature individuals and certainly persons past middle age are so set in their ways, so preoccupied with other things, and also so sensitive to correction and criticism, that they could not learn so well as younger individuals. But clearly this is no fundamental disability. We may say then that age is no barrier to learning, although, since such practical considerations are not easily overcome, it is fair to say that the younger a person is, the greater his capacity for learning.

Certain experimental studies have also indicated that the age in animals does not materially interfere with learning.

LEARNING MATERIAL.—The nature of the material to be learned invariably conditions the learning process. Some activities are simple and more attractive, while others are difficult and complex. It is a safe generalization that the ease or difficulty of certain materials depends upon whether it fits into the general scheme of the person's life. To learn certain things for some persons is an abhorrence or a necessary evil, while for others the same material is seductive and tempting, teasing them on to master it.

For this reason some children are exceptionally good at arithmetic, but do not read well, while others learn their geography readily and effectively, but do not take to arithmetic. Other differences are discernible too. Some persons go in for skills, but are not keen on informational materials.

Carr[3] cites some results for the memorizing of pairs of nonsense syllables, where the influence of the material is more manifest than the individual differences. It required five times as long to learn a series of 36 pairs of syllables as a series of 12 pairs. Thus it took one subject only 7 minutes to memorize the short series and 34 for the longer one, while another subject required 13 and 65 minutes respectively. When the material is only three times as long it requires about five times as long to memorize it.

General Surrounding Conditions.—Heading the lists of such conditions are the general opportunities to come into contact with certain kinds of material. The premiums that fathers used to pay masters to accept their sons as apprentices are in some sense a measure of the value of such opportunities. But the general surrounding conditions also operate as determinants sometimes by virtue of necessity. When thrown into the water you simply must learn to swim. The fact that immigrants learn how to use a foreign language better in a week than a book scholar does in months illustrates the same kind of necessity as a learning condition, though now it is a cultural instead of a natural circumstance that operates.

B. *Special Conditions*

Goal of Learning.—To have one's goal prominently before one is an effective influence upon learning. This means in effect that the stimulus must constitute a prominent feature of the learning situation. Success in learning depends a great deal upon whether or not the individual appreciates the nature of the problem and what he is expected to accomplish. It is no doubt the individual's appreciation of the learning goal which is responsible for his ability to adopt means for accomplishing his learning purpose. Such appreciation we take to be the first step in the employment of insight as a learning procedure.

Motivation.—Besides implying a definite goal, learning is conditioned by the motives which activate the individual. It is not only necessary to have some kind of result in view, but one must be activated in reaching one's objective. Among such motives are the necessities of the situation. In order to learn a certain game one must appreciate the value of pleasing someone or achieving thereby some kind of desirable position.

[3] Psychology, Longmans, Green, 1925, p. 227.

An interesting experiment in motivation was conducted by Book.[4] He compared two groups of subjects who were practicing to improve their capacities in (a) writing a's, (b) substituting letters for digits, (c) canceling letters, and (d) silently multiplying two-place numbers. The one group was allowed to count and record their own scores and were constantly assured of their progress, while the second or control group were not so motivated. Fig. 57 indicates the results.

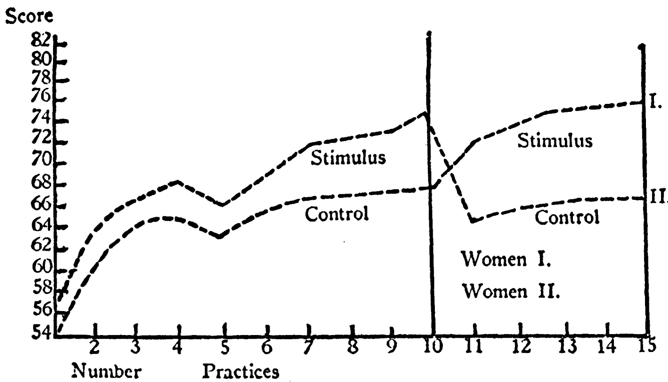


Fig. 57—Book's curves showing influence of motivation. Notice the change in curves when the control group becomes motivated. From Book, *Learning to Typewrite,* Gregg, publishers.

Anyone who has observed learning activities of children in groups knows how influential competition and rivalry are. The very fact of working against someone with a possibility of beating him adds the zest of sport to the process and transforms work into a game, with corresponding advantages in the results obtained.

INTEREST.—Sensitivity to the situation, both the nature of the goal and the necessity to reach it, are essential to success in learning. Willingness to abide by the dictates of society, the demands that one develop certain knowledge and techniques, or a personal inclination to acquire certain behavior has a very large influence upon learning.

Peterson[5] obtained some interesting results in the following experiment. He asked his class in psychology to copy down twenty words which he wrote upon the blackboard. Then he asked them to

[4] Book, W. F., and Norvelle, L., The will to learn, *Ped. Sem.,* 1922, 29, 305-362.

[5] Peterson, J., Effect of attitude on immediate and delayed reproduction, *J. Ed. Psych.,* 1916, 7, 523-32.

reproduce the words immediately on the other side of the paper, and also 48 hours later. This procedure was repeated at another time, but now the class was told that the words would be called for. The additional interest aroused by the instructions influenced a marked improvement in the amount of material the students could reproduce, both immediately and after forty-eight hours.

The same type of investigation by Meumann and others showed that a saving of fifty percent was effected by the interest aroused through expecting to be called upon for the material learned. Sanford points out that it is the lack of interest which accounts for learning practically nothing from a daily reading of the morning service.

Aids to Learning

Educational psychologists have amassed a series of data which throw light upon various processes serviceable in learning. This material they speak of as the economy of learning.

Distribution of Effort.—When students are assigned a task, say a chapter to read, should they persist at it until they have learned it or should they keep returning to it several times? In short, is it more economical to attack a learning problem with one great effort or should the learning activity be distributed?

Psychological opinion favors the distribution of learning effort. Whether it is a mechanical activity that is to be learned or informational material it is advisable to distribute the practice over different parts of the day or over several days.

A sample experiment in this field is indicated in the accompanying table. Compare the scores of the two subjects for the different distributions of the twenty-four readings of nonsense syllables. The results seem to indicate that the interposition of rest intervals between the trials is more economical than the massing of the effort.

Comparative Advantages of Distributed Effort
(From Jost)

Days	Readings	Score of Subject B	Score of Subject M
3	8	18	7
4	6	39	31
12	2	53	55

The precise distribution of effort, of course, depends upon the kind of learning problem and the individuals who perform the learning behavior.

Length of Study Periods.—How long should one continue at a prescribed task? There is no question but that there are optimal study periods. By an optional period we mean that if we stick to a certain problem for a longer or shorter time the learning will not be so effective. It must be understood, of course, that optimal periods of study are very specific things and that they depend upon the individual and his condition as well as upon the type of material.

A definite laboratory answer to the question is supplied by some data which Pyle has secured. This investigator had a group of subjects working on a substitution problem. He had his subjects translate words into symbols by substituting particular symbols for the letters according to a fixed code. His subjects were divided into four groups, each of which practiced sixteen days for fifteen, thirty, forty-five, and sixty minutes respectively. The results secured are indicated in the accompanying table. Observe that the thirty minute period proved the most efficient while the sixty minute period was especially ineffective.

Learning by Wholes and Parts.—Supposing that we have a poem to memorize, should it be read over from beginning to end a sufficient number of times until the poem can be repeated "by heart," or should the learner proceed to fix a part and then take up the other portions? The data on this question are not conclusive; so that no generalization can be made. With some material and with some subjects the whole method is preferred, while in other cases the part method is more economical.

Rhythmical Performance.—Subjects who participate in experiments on learning of nonsense syllables and the memorization of poetry report that to rhythmize the performance is a very effective aid in making progress. In the case of memorizing poetry the attempt to get into a rhythm of verbal action makes an effective bridge between the whole and part methods of learning.

In learning nonsense syllables, and especially those in which meanings are effectively excluded, the rhythmic repetition of the syllables is in some cases the only way in which any effective memorization can proceed. The whole process of learning meaning-

How Speed of Substitution Is Improved by Varying Practice Period
(From Pyle)

Group	Length of Period (minutes)	Relative Improvement %
A	15	22.3
B	30	36.1
C	45	25.0
D	60	14.8

less syllables consists in organizing a complex set of verbal actions cemented together by a certain rhythm.

RECITATION.—Various investigators have secured data indicating that to begin performing an action that is to be acquired is a great aid in learning it. To illustrate, Gates compared the learning of sixteen nonsense syllables and five short biographical sketches (170 words) by two methods. In the first the subjects read and reread the material without looking up from the paper. In the second the subjects looked away from the paper and recited the material as soon as possible. The advantage of the second or recitation method of learning is indicated in the following table.

Influence of Recitation Upon Learning
(From Gates)

	Percent Memorized			
	Nonsense syllable material		Biographical material	
	Immediately	After 4 hours	Immediately	After 4 hours
Reading without recitation	35	15	35	16
1/5 of time devoted to recitation	50	26	37	19
2/5 of time devoted to recitation	54	28	41	25
3/5 of time devoted to recitation	57	37	42	26
4/5 of time devoted to recitation	74	48	42	26

Gates points out that the advantage of the recitation method is that the student learns his material just as he is going to use it later. Also he discovers by his attempts at recitation what parts are especially difficult or easy. And finally, the student can check the progress of his learning. This, as we have seen, is an important condition of learning.

FORM OF PRESENTATION.—Some students report that they can get much more out of a lecture on some subject than they can from reading a book discussing the same material. This type of student therefore cannot afford to miss his lectures. Incidentally, too, he is tied up with his class meetings. Another type of student, on the contrary, can more easily dispense with lectures and in fact could use his time to greater advantage in the library than in the lecture room, unless the lecture material is not available in a textbook. A more extreme form of this type of individual difference is indicated by the case of the person who cannot make out what he should do from printed directions, but must be told by word of mouth what needs to be done.

Since it is generally agreed that these differences are based entirely upon the reactional biography of the individual, a part of every person's learning activity should be devoted to acquiring the capacity for profiting by various kinds of contact with learning material.

FREQUENCY OF PRACTICE.—The proverb "practice makes perfect" indicates a definite psychological aid to learning. In order to master a subject, whether it be informal learning or skills, one must frequently perform the activities in question. All this is common knowledge and need not be repeated. But to mention practice is to suggest two important points. First, this proverb is true only of the learning that requires practice. We too often overlook that many activities can be learned the first time and require no repetition. In the second place, when practice is required it must be adapted to the task at hand. Just how frequently one must practice a certain action depends both upon the individual and the character of the material to be learned.

Interferences in Learning

RETROACTIVE INHIBITION.—It has been definitely determined that when one is learning a certain kind of material and turns im-

mediately to another type there will be an interference in learning. Experimental results have indicated that if one learns a maze and then soon after learns the pathway of another maze, an interference in learning results. The general principle seems to be that to learn two forms of the same type of activity in too close proximity causes considerable interference, whereas two unrelated forms of activity do not conflict with each other. This type of learning interference has been called retroactive inhibition.

Distraction.—Engaging in social activities is often given as an alibi for not learning a prescribed college assignment. This is an illustration of one type of distractive influence in learning. A more serious form falling without the control of the individual is worry. Under such circumstances it is impossible to carry on learning activities effectively.

The Stability of Learning

How long will a stimulus and response coordination endure after it has been effected? When we learn important materials the ideal situation, of course, is to acquire them as permanent behavior equipment. But we know, however, that this ideal situation seldom if ever prevails. Exact data as to how stable learning is, has been obtained from experimental learning situations.

Tests of Learning Stability.—In general, there are three tests or methods of determining how long learning lasts. These go by the name of (1) the reperformance, (2) recognition, and (3) saving method.

(*1*) *Reperformance.* This method, also named the method of *recall* and *paired associates,* was introduced by Calkins and elaborated by Müller and Pilzecker. It consists essentially in presenting associated pairs of material, such as two words, a color and a word, or a word and a figure. Later one member of the associated couple is presented as a stimulus, and the learner states if he can what was connected with it.

(*2*) *Recognition.* The recognition method consists in presenting to the subject the materials which he learned, along with others that were not connected with it. Thus, if the subject has learned a certain series of nonsense syllables, other syllables are presented along with them. The learner must be able to recognize which are and which are not part of the original learning material.

A variant of the recognition test is the *rearrangement* method. Here the learned material is presented a second time, but in a different order. The stability of learning is measured in terms of how well the subject can put the material back into its original arrangement.

(*3*) *Saving Method.* This method, sometimes called the *relearning* method, consists of a comparison between two learnings of the same material. The method implies that the learner has not permanently coordinated the stimuli and responses, but that a re-

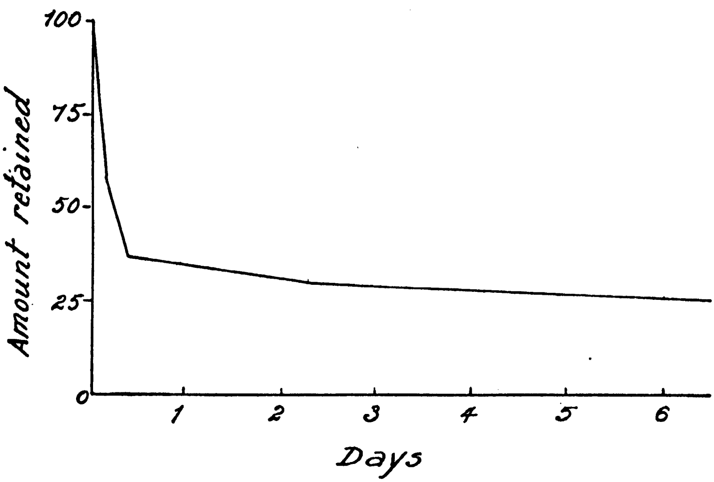


Fig. 58—Ebbinghaus' curve of retention.

learning will not require so long a time as the first attempt. The person who required ten minutes the first time to learn a series of nonsense syllables and five the next is said to have achieved a fifty percent stability in his first learning.

None of these methods is really an adequate measure of learning stability. As a matter of fact, they give different results with the same materials. In general the recognition test shows the highest amount of learning stability, a result which is clearly owing to the kind of situation which it represents.

Curves of Learning Stability.—On the basis of such tests as we have just described students of learning have constructed

curves to show the stability of learning. Learning stability can, of course, be represented in two ways. For example, there is Ebbinghaus' curve of forgetting constructed by plotting the percents forgotten on the vertical axis, and the time intervals between learning and relearning on the horizontal axis. The converse retention curve can be constructed on the basis of the percents retained (Fig. 58).

An interesting comparison of results on the same kind of material is afforded us by putting together in parallel columns (as below) the figures of Ebbinghaus and Radossawljewitsch. Both experimenters found that at first there is a very rapid forgetting, but as

Comparison of Two Sets of "Forgetting" Data

Length of Interval	E	R
	Percent Forgotten	
5 min.		2.5
20 min.	41.8	11.4
1 hr.	55.8	29.3
8 hr. 45 min.	64.2	
8 hr.		52.6
1 day	66.3	32.2
2 days	72.2	39.1
6 days	74.6	50.7
30 days	78.9	79.8
120 days		97.2

time proceeds the loss is relatively slower. The reader will notice, however, that Ebbinghaus found a larger percentage forgotten in the short periods. Thus, whereas according to Ebbinghaus 55.8% is lost by the first hour, Radossawljewitsch's figures show that six days must elapse before a 50% permanent loss is shown. At six days Ebbinghaus reports a loss of 74.6%. As we have already seen, with other than nonsense syllables the results are quite different.

INFLUENCE OF SPEED UPON STABILITY.—It is a very interesting question to ask what influence rapidity of learning has upon its stability. It is a common but erroneous impression that the more rapidly one learns the quicker one "forgets." When we reflect upon the situation we observe that we should really expect the contrary to happen. Learning is not always a mere matter of hum-

drum repetition of action. Complex learning involves insight and the observation of logical relations. Accordingly, the learning of the keen individual need not at all be less stable than that of the person who is slow to see through a situation. Similarly, the keen learner can retain his knowledge and skill learning as long as the learning that requires slow development.

CHAPTER XVIII

THINKING, PROBLEM SOLVING, AND REASONING

Complex Adjustments Require Thinking

Many of our adjustments occur immediately in an entirely satisfactory way. What is necessary to be done is definitely indicated by the nature of the stimulating circumstances, and by the behavior equipment that the individual has acquired throughout his reactional biography.

In other cases we face difficult and problematic situations. The behavior to be performed is not plainly marked out. Also the individual may not be equipped with reaction systems that enable him to meet directly the behavior conditions at hand. In almost all of our complex conduct we are involved with such recondite and perplexing circumstances as call for thinking, problem solving, and reasoning.

A. Thinking Behavior

THINKING NOT MERELY IMPLICIT BEHAVIOR.—"A penny for your thoughts." Here is a typical illustration of how the term thinking is frequently employed. Now at first glance it is quite evident that the term as used here stands merely for implicit behavior of some sort. You ask this question of a person who is musing or perhaps day dreaming. Not only laymen, but psychologists confuse the more or less playful and superficial actions of daydreaming with thinking. Although thinking does indeed consist in large part of implicit behavior, we must differentiate sharply between such actions and the more serious thinking adjustments to complicated situations of life.

Thinking involves some serious adaptation. When it consists of implicit behavior it may be described as a preliminary implicit handling of things in order to achieve an effective result. Before

a house can be built it must be planned; no machine can be constructed without being designed. In brief, all intricate actions must be decided upon before being carried out. Without such preliminary behavior our performances could not be effective, if they could be executed at all. Only in this way can we be sure of not wasting more than a minimum of effort, time, and money.

THINKING NOT MERE ORIENTATION.—It follows also that thinking is not just orientation as is knowing. There appears to be a much closer connection between thinking and some further overt action than is the case in knowing, although in both the behavior segments may be connected with more effective forms of behavior.

MANY SORTS OF THINKING BEHAVIOR.—Our complex interactions of the thinking group comprise a number of distinctive adaptations. To pass judgment upon something is very different from planning an enterprise. In the following pages therefore we shall endeavor to distinguish some of the more prominent forms of thinking.

Judging

The paintings submitted for the annual exhibition have all been hung; it remains for the judges to award the prizes. What the judges are called upon to do is to develop an attitude as to which painting is the best, which the next best, and so on.

Judging then is the process of developing an attitude toward the stimulus object. Sometimes the attitude is absolute in the sense that it is based upon the known or ascertained qualities of a thing, irrespective of any other object. On the other hand, the judgment may be comparative as in the case of the painting competition. Each picture is treated in relation to other pictures. In our illustration the act of judging implies that objects have been given a place in a series. It is sometimes true also that judging implies placing objects inside a class.

TYPES OF JUDGING.—Since judgments are no exception to the rule that psychological activities are specific interactions, we may classify judging responses into types on the basis of the things to which we build up attitudes.

So far we have mentioned only judgments concerning things. Attitudes are developed not only to their qualities; we may also

judge whether or not a thing is good for a certain purpose. Our interest may go beyond its immediate character to its availability for our future uses.

Many of our judging reactions have persons as their stimuli. We are called upon to judge whether they are guilty or not guilty, responsible or irresponsible, competent or incompetent for various purposes.

Quality of Judging.—Upon what basis may judging reactions be regarded as different in their qualities? Is the judgment a snap one, touching only the superficial conditions of the objects or persons judged, or does it involve an investigation of the nature of the stimuli? Snap judgments, of course, cannot have the significance of measured judgments and are not therefore so effective as components of complex adaptations. Measured judgments, on the other hand, indicate the individual's acquaintance with and appreciation of the things judged. Incidentally, snap judgments are usually very simple forms of interactions, while the measured types are rather complicated.

Personal and Impersonal Judging.—A competent judge develops his attitude toward a thing primarily on the basis of its qualities. Such a judge we call objective, and we regard his judging behavior as impersonal. On the other hand, the individual may ascribe qualities or properties to things on the basis of his experiences with them, or because of some need that influences his action. Very often our judgment is prejudiced by our feelings. This kind of judging is personal and subjective. In such thinking we are more easily swayed by other persons. Thus it is a common practice for lawyers to exhibit the wife and children of a defendant in order to affect the judgments of the jurors concerning the prisoner.

Evaluating and Criticizing Responses

When a diamond necklace is brought to a jewel expert it is presupposed that he can evaluate it, because he knows the standards of perfection and economic value. It is his task then to discover to what extent this object conforms to these standards. Similarly, when a dramatic critic asserts that a play does or does not possess fine dramatic qualities or aesthetic form he is passing judgment on the quality of an author's work from the standpoint of certain established literary principles or canons.

When we criticize or evaluate an object we come very close to judging it. But whereas in judging we develop an attitude with respect to stimulus objects on the basis of their qualities or our previous experience with them, in the case of evaluating or criticizing we measure an object according to some more or less definite standard or criterion.

Planning

Human circumstances demand constant preparation for future behavior. We must think out what we are to do in order to do it properly. What kind of garden would we have if we did not figure out its details the winter before? Similarly, we might ruin our vacation did we not prepare for it in thought a long time in advance.

Such thinking activity in which we definitely anticipate some future behavior we call planning. Just what is the nature of this kind of thinking? Of necessity it involves a great amount of implicit handling of things, persons, and circumstances by way of preperforming the action in which we are interested. But such planning is not all implicit. We also calculate, draw designs, make inquiries, exactly in the measure of the intricacy and importance of the work to be done.

The work of an architect in planning a building is the best example of this kind of thinking. The immediate task is designing a skyscraper. Here is a new and unique kind of behavior situation. This means that the architect is obliged to work out a project with definitely circumscribed boundaries. The new building must be safe, serve certain purposes, bring in a certain income, and look attractive and suitable for the land upon which it is to be built and the surroundings in which it is to be set. The architect's planning behavior may thus be said to consist of implicitly erecting the skyscraper long before the structure which it replaces is even torn down.

Before the gross handling of the steel and stone can be undertaken the designer must anticipate every possible detail of construction. Indeed the planning of a skyscraper on paper may cover a much longer period than does its overt construction. Not only must every bit of material be accounted for, articles manufactured in this and other countries, but their qualities and costs must be investigated. It is not merely a figurative way of speaking to say that the architect must handle, implicitly, of course, every beam and girder as well as every knob and faucet. Furthermore, every piece

of architectural planning calls for knowledge of and control over scores of trades and labor conditions. If we add to all this the excavation conditions that must be anticipated, as well as the artistic and economic foresight demanded, we begin to realize the complexity of the preperformance character of planning.

Explanatory and Interpretative Thinking

The morning paper carried the news that the banker "X" has been arrested for embezzling the bank's funds. Here is a situation which demands an explanation, and which calls into play all my knowledge and habits of thought. I explain this situation as one of those mistakes which frequently happens in the newspaper world. Someone has made a blunder. Or, if the probability of embezzlement is greater, I may explain it as an abnormality of conduct. People are sometimes subject to unaccountable actions under certain conditions. Again the situation is attributed to a technical error. The banker really did not intend to do wrong; he simply took some funds planning to return them soon, but in the meantime the shortage was discovered.

Thus I interpret the action as neither negligent nor criminal. Technically speaking I relate the present behavior of the banker to his other conduct of which I know, and in general account for the present situation in terms of other facts. Explanatory and interpretative behavior is essentially the interrelation of one event with another. It is analogical.

Sometimes, too, I account for a thing in terms of a part of it. I interpret what a person says on the basis of a word he uses or a sentence uttered.

Notice that explaining and interpreting things are very different reactions from excusing or rationalizing them. The latter consists primarily of offering some statement satisfactory to oneself as to how things happen, but it does not necessarily involve any genuine behavior interrelation of objective facts.

Deciding and Choosing

Some of our thinking behavior consists essentially of weighing evidences for or against a certain object or action. When we perform a choosing response we determine upon a preference for some object as over against another. Which of two automobiles should

we purchase? One of them is in price nearer our purchasing capacity, while the other has much more desirable lines and equipment. Now the choosing activity consists primarily in determining whether the superiority of the second car overbalances the more suitable price of the other.

The same general behavior conditions are involved in the case of deciding, but here the emphasis is upon some action we should or should not do. In many instances the two types of thinking may be sharply distinguished, but in other cases they appear to be merely phases of the same general thinking situation. Thus in choosing, the stimulus object with which we interact appears more prominent, whereas in deciding, the emphasis is upon our response rather than upon the stimulus object.

Decision and Indecision.—Our weighing and balancing of two alternatives does not always result in a definite decision. The two automobiles may turn out to be of equal value and importance. Accordingly, our thinking action ends in an *impasse,* an indecision. The person is suspended as it were between two situations without being able to act with respect to either one. In such a circumstance we might say that we decide that we cannot act rationally. If conditions demand action, however, as when we must make a visit to a distant city by auto, we simply must close our eyes and leap.

James's Five Types of Decision.—James has described in his inimitable style the response pattern of the individual in resolving the alternatives set up by competing stimuli. Now although James wrote from the standpoint of mentalistic psychology, the situations which he describes can be easily translated into terms of stimulus-response interactions.

Passive Settlement.—A senior leaving college is offered two positions. The one in Chicago pays a little more than the one in Indianapolis. The slightly higher salary, however, is quite offset by the much lower living cost in the smaller city. But on the other hand, Chicago offers certain advantages in the way of music and the theater which are irresistible. In this case the competition between the stimuli becomes settled by the consideration of the stimulus conditions resulting in the clear superiority of one over the other. The study of the alternative circumstances leaves no doubt that one should be preferred as the stimulus for action, while the other should be suppressed.

Conclusion Forced by External Factor.—Suppose that consideration of the alternative circumstances does not lead to a clear advantage in favor of one or the other. Our senior then faces a dilemma. In the meantime he learns that X has accepted a place in one or the other of the two cities. This circumstance is sufficient to affect his decision. Our senior then assumes the attitude that he might just as well go to the same place, especially since it is better to do something than to continue his wearisome vacillation.

Conclusion Forced by Need for Action.—In another situation no such external factor comes in to save the day. Moreover, the respective employing firms insist upon an immediate acceptance or rejection of the employment offer. Our senior is also convinced that enough time has been spent on a study of alternatives. He thus is led to a high pitch of resolution and forthwith decides, with the possible reinforcement lent him by the idea that in either city, his future will be assured. "I am going to Chicago," he declares, though he does not know exactly why.

Decision by Change of Attitude.—Should one contribute a large or small sum to a charitable cause? Almost at once the smaller amount seems not only justified, but more appropriate. But no, the individual is immediately stimulated to reject this easy form of decision. His moral attitudes force themselves to the surface and by their influence the situation is changed from an economic to a moral issue. The decision to give the larger amount consummates the activity.

Decision by Extreme Personality Emphasis.—X's friend is about to compromise himself by some apparently ill-advised behavior. Shall X interfere or not? If he studies the situation he may find either that he should or should not. But he decides at once not to interfere at all. Obviously the decision is not founded upon evidence, since he does not know what a study of the case would reveal. On the contrary, his decision is made on the basis of principles and ideals which are components of the individual's equipment irrespective of the particular conditions found in the present conflict. He decides upon the principle that he will not interfere in somebody else's affair even though he should discover that his friend will almost ruin himself by the contemplated action.

Predicting and Estimating Behavior

When the contractor estimates the cost of a building upon which he wants to bid he is performing the most obvious form of anticipatory action. The same may be said of the forecaster who undertakes to make a weather prediction. In both cases the behavior consists primarily of observing, summing up, and calculating the similarities and dissimilarities in past situations which may be connected with those impending. Predicting and estimating are definite attempts to bridge the gap between the past, present, and future in our effort to adapt ourselves to future happenings and impending contingencies.

Speculative Thinking

The distinctive mark of speculative thinking is its remoteness from stimulus objects. There are naturally many degrees of such remoteness, the upper limit being the complete absence of a real adjustment stimulus. Such was the case when the medieval schoolmen were reported as speculating how many angels could dance on the point of a needle. The basis for their activities was, of course, all kinds of assumptions, conjectures, and conceptions.

A more plausible form of speculation is found in the case of the public lecturer who meets his audience for the first time and consequently is uncertain as to its intellectual status or background. As a result of this condition he can only speculate concerning what manner of speech he should deliver. Under such circumstances one's behavior cannot naturally be guided by actual information.

B. Problem Solving

(When we perform problem solving behavior we attempt to extricate ourselves from some difficulty or to resolve some sort of perplexity. The stimulus for such action is, therefore, a problematic situation.)

Consider the notorious events which occurred in Paris on March 23, 1918.[1] In the early morning of that day the citizens of Paris were thrown into great excitement by a series of explosions which produced considerable damage, killing a number of people and

[1] For the factual materials the writer is indebted to Henry W. Miller's volume entitled The Paris Gun, Cape and Smith, 1930.

destroying a great many buildings. The problematic situation was a poignant one.

What caused the explosions? How were they brought about? The first suggestion, of course, was that Paris was being subjected to an air raid in spite of the fact that no daytime bombing had occurred since May 11, 1915. Despite such an improbability, air observers were sent up two or more miles into the sky to search for bombing planes or zeppelins. To no purpose, of course.

That the explosions were not caused by bombing planes became quite evident when it was discovered that the fragments of the metal from the exploding objects were made of steel over two inches thick and were supplied with copper bands. Such objects were not known to be used by air raiders. These explosions therefore were not brought about by bombs at all.

The conclusion was forced upon investigators that the objects that brought about the damage were really projectiles which could only be fired from guns. But this was thought impossible.

Soon the theory was forthcoming that the missiles were fired into the city from French guns. It was said that the last issue of war bonds was not being eagerly subscribed for and therefore the promoters of the war were stimulating the fighting energies of the French by making them believe they were under gun fire. This seemed a monstrous suggestion, for no French authorities could be destroying so many lives and risking the greatest treasures of the French nation.

Well, then the Germans must have advanced far enough into the French lines to be able to bombard the city. The largest cannon range known was about twenty-five miles. Military experts knew that there was no foundation for such an hypothesis, since the German lines were actually about three times that distance from the city. Such an idea could only be based upon rumors spread by German sympathizers.

The possibility then had to be considered that the projectiles were really coming from the German lines, but apparently were fired by a gun with a range hitherto unheard of. Experts were called upon to investigate the possibility of such artillery and came to the conclusion that such long range bombardment could be possible if tremendously high muzzle velocities could be attained, and if such an angle of elevation could be employed that the gunners could take advantage of the lack of resistance in rarified air.

Such was, of course, the case. The German army had developed a super cannon, the famous "Paris gun," with a velocity of over a mile per second that would send the projectile to a height of twenty-four miles, and over a range never before supposed possible. It was finally concluded that the Germans were bombarding Paris from the Laon region with artillery that could fire projectiles over a distance of seventy-five miles.

Now let us briefly abstract some prominent features from the problematic situation and its solution. It is evident that the final solution of the problem was reached by means of testing out various suggestions, discarding those found unsatisfactory. In every complicated problematic situation numerous clues must be run down and investigated until finally the true answer to the original question is obtained.

An excellent formal statement of an ideal problem solving situation is offered by Dewey.[2] He suggests that there are five distinct steps in solving a problem. (1) First, there is an appreciation of a problem or difficulty. (2) A preliminary investigation of the problematic situation is then made; so that the nature of the problem is understood. (3) Next come the suggestions for the solution of the problem. (4) The fourth step consists of testing and weighing the solution; so that it is accepted or rejected depending upon how reasonable it seems. (5) Finally, the fifth step involves the overt testing of the accepted solution. This is a practical or experimental verification of the accepted solution.

In actual practice, however, there may be so many variations in the way one solves a problem that no formal description can be valid. Again, the foregoing stages are descriptive only of practical problem solving. In theoretical situations the fifth step cannot be added, since no effective manipulation of things is involved. Dewey has himself pointed out that steps one and two may fuse, since the first appreciation of a difficulty may lead at once to suggestions for a solution.

Furthermore, problem solving is not always an orderly series of responses, but a chain of suggestions and tests, or even a series of intermixed cross currents of hypotheses, and their acceptance or rejection. In our illustration, for instance, the nature of the bombardment was really a phase of the larger problem of how to avert the danger and to prevent damage.

[2] How We Think, Heath, 1910, ch. 6.

In describing problem solving we must take into account the nature of the behavior circumstances as well as the individual differences of persons. Not all situations lend themselves to a logical series of behavior performances. The world of happenings is not as static as all that. As far as persons are concerned we notice that some individuals jump at a solution without any thorough examination of the nature of the problem or the circumstances under which it occurs.

When no practical testing of the conclusion is possible the solution may be either right or wrong, feasible or not feasible. Here the intelligence and expertness of the person are important factors. When a test is possible the person who jumps at conclusions may have to go back and examine the problematic situation, but he may jump at another wrong conclusion before doing so. At any rate he does not follow the ideal order of procedure.

It frequently happens also that persons are not convinced by fair evidence. For example, referring again to the "Paris gun" illustration, there were many people who did not give up the hypothesis of air raids after the evidence seemed to be against it. They still insisted that bombs must have been dropped from planes too high to be observed. Many Parisians refused to accept the long-range gun theory, arguing that the projectile after being fired from a gun must have had some further gas explosions to have carried it so far. Others clung to the idea of a marvelous catapault, while still others maintained that the projectile was itself a cannon which fired a second shell to complete the distance.

Let us notice, too, that some persons are cursed with the habit of so prolonging their investigative procedure, pondering over a suggested solution for a problem to such an extent that they fail to reach an accepted solution on time.

We must insist therefore that any formal description of problem solving can only be a logical statement of what persons ought to do when circumstances permit, in order to solve problems effectively. Obviously, there is a wide gap between the logical and psychological procedures of problem solving. It must be indicated, however, that when persons attempt to solve problems as technical scientists, the psychological and the logical procedures may coalesce.

C. Reasoning

The student may be surprised to learn that when he goes back into the house to fetch his umbrella after observing the clouds in

the sky he has performed a reasoning response. Such is nevertheless the case. The clouds have stimulated the reaction of believing that it will soon rain. Of course, this is a simple form of reasoning, a kind of reasoning habit—but it is none the less reasoning.

Reasoning is essentially inferential behavior. When we reason we interact with things in such a way as to develop a new intellectual orientation or understanding with respect to a stimulus object or situation. Such reactions in which new ideas or attitudes are developed are commonly called drawing conclusions.

With this characterization we may distinguish sharply reasoning from thinking. Although thinking may also lead to a new attitude toward something, it is primarily an anticipatory form of action necessary to carry out some other behavior. Thinking may therefore be regarded as a preperformance.

Reasoning may also be distinguished from problem solving since the latter is designed to extricate us from some immediate perplexity. For the most part, reasoning behavior does not necessarily result in the transformation of one's circumstances, although the new intellectual position that one achieves may be connected with some practical performance. This is the case in our umbrella illustration. It is clear, however, that we can always clearly differentiate the two types of action.

Naturally, inferential responses occur in many behavior situations. Each one of these different types of reasoning constitutes a unique form of interaction. Five of these forms of inference we shall now consider.

Inductive Inference.—In planning my garden I have been looking through no less than ten different seed catalogues. I find that every dealer promises me beautiful and hardy plants. From these observations I conclude that either the dealers are exceedingly intent upon selling their merchandise or they are indifferent to the truth of their statements. Or else they all sell the same high grade of seeds. My reaction to these different stimulating objects consists then essentially of acquiring a new idea or attitude. My intellectual horizon is thereby enlarged. Now I appreciate the general characteristics of seed sellers. This inferential reaction may then be described as the achievement of a generalized attitude with respect to particular kinds of stimulation with which I have been in contact.

Inductive inference then, we conclude, is primarily the process of generalizing on the basis of a number of specific observations. A series of instances stimulates the individual to achieve a general understanding. We observe that water dissolves salt as well as sugar; more still, it also has the same effect upon metallic substances, though slower. We therefore come to appreciate that water will dissolve anything, or that there is nothing that cannot be dissolved.

Deductive Inference.—When we make inferences by the deductive process we place some object or person in a series or class. Essentially this is a form of knowledge in which we see where a thing belongs. The botanist studying the various forms of flowers and noticing the gradations in the resemblances between the flowers and the leaves infers that the blossom is nothing but a specialized form of leaf structure. The psychological process here is observing that the blossom really belongs to the leaf class structure. Thus the observer achieves the understanding of the place of a thing, the nature of the blossom with respect to the other parts of the leaf.

We notice that the deductive form of inference implies that something is already known and that the behavior result is a form of classification and not the development of a totally new generalization.

Conductive Inference.—That tire which wore out so quickly cost me ten dollars. Naturally such a tire did not satisfy me at all and I must by all means avoid getting that kind again. Today, when I negotiated the purchase of another tire, the price quoted was just the same as the former one. Immediately I infer that here is another tire that will not give good service. In this behavior situation I come immediately to a conclusion based upon an analogy or similarity in the two things. In a sense this is also a case of seeing where a thing belongs or placing it, but unlike deductive inference I am not just placing a thing in a class, but relating one thing to another.

Here is another illustration. I see a carpenter working, and to my inexperienced eye it appears that he is using the same technique as another carpenter who made a fine cabinet for me. I infer then that this new piece of furniture will be equally as good as the other. Now it makes no difference in the description of this specific response whether I infer correctly or incorrectly. The whole point

is that I am stimulated by what I see to develop an intellectual orientation.

Evaluative Inference.—Here my reaction consists in concluding something about the value of an object. The employer who interviews prospective employees observes that one candidate for the position speaks in a straight-forward manner. The other hesitates and is rather uncertain in his answers. He concludes therefore that the former individual is the superior person. This type of action we see is definitely an evaluative form of reasoning. Because of certain characteristics the employer comes to a conclusion concerning the value of the applicant.

Reductive Inference.—As a last illustration we consider the behavior segment in which the responding individual concludes that his previous intellectual orientation has been wrong. For example, I have always thought that grade school teachers were always women, but today I came across a school in which a man conducted a primary class. Thus I come to a conclusion that my former information was rather faulty. I know that I did not know. I might have discovered that my intellectual attitude was not entirely wrong, but only doubtful and incomplete. The negative instance which I have discovered forces me to the conclusion that I lack a stable intellectual position.

Reasoning about Things and Propositions

When we infer from the impressions of the automobile treads in the snow of our driveway that the grocer has already delivered his daily order, we are reasoning about objects and events. It is possible that reasoning concerning objects comprises on the whole the simplest form, although when such reasoning is part of serious scientific work it may be very complicated and difficult indeed.

Reasoning May or May Not Be Critical

As our discussion has amply illustrated, reasoning is a technical form of behavior in which a new attitude is derived from a consideration of stimulating conditions. It must not therefore be assumed that all reasoning is critical and competent. In other words, whenever we study reasoning behavior we must institute a double inquiry. In the first place, we must examine whether or

not the reacting person is drawing conclusions, and secondly, whether he appreciates the nature of the observed thing or understands properly the propositions from which he draws his conclusions. It is only in the latter case that reasoning is critical.

Reasoning then may be uncritical, but is such action always invalid? That depends. If we mean by validity the usefulness of a reasoning activity it is quite possible that reasoning may readily be valid without being critical. Let us not forget that reasoning behavior may occur in situations in which no practical check of the processes involved are available. Under these circumstances the validity of reasoning may be decided entirely upon the basis of whether or not the process and the results satisfy the person concerned.

Reasoning and Rational Behavior

It is one of the *mots* of Aristotle that man is a rational being. Whether or not this *mot* represents an actual situation is doubtful, but certain it is that ordinary inferential conduct is not rational behavior. Our discussion of critical reasoning clearly suggests that one may draw a great many inferences from observations, and from examination of propositions without being rational in one's conduct. Behavior is rational when it is based upon the actual nature of stimulational conditions. In order to treat diseases rationally the physician would have to know thoroughly the nature of the pathology with which he is dealing; he would have to be familiar with the causes of this condition, and in possession of the knowledge how to eradicate such causal factors by suitable remedies. This is very often not possible in medical practice. In other words, the mere act of inferring what the difficulty is from certain symptomatic observations and the making of a satisfactory suggestion as to cause and remedy are not in the fullest sense rational behavior.

If this is true of actions founded upon the sciences, it is true in greater measure of other activities not based upon so secure a foundation. Nevertheless, in view of the fact that in so many instances genuinely rational behavior is impossible, careful and conscientious reasoning constitutes quite as satisfactory a form of adaptation as genuinely rational behavior.

CHAPTER XIX

LINGUISTIC INTERACTIONS

Speech is undoubtedly one of the most predominant forms of human behavior. Consider that man's activity is inevitably set within the background of social intercourse. He cannot live alone. Therefore it is necessary for him to speak and be spoken to. Otherwise men could not work together, buy and sell from each other, plan or play with each other, in short carry on any cooperative enterprise. Language activity it seems clear is among the most pervasive forms of action and probably constitutes one of the largest portions of our conduct.

Language behavior is just as important as it is common. Linguistic activity in some form or other is basic to all of our complicated forms of conduct such as thinking and reasoning. Behavioristic psychologists even go so far as to declare that thinking and reasoning are hardly anything more than verbal behavior of a subvocal type. No doubt this is an exaggerated statement, but there is no question that the development and use of concepts are most powerfully aided by our ability to perform language responses.

Still more, we might regard language as the most characteristic of the human forms of action. Sub-human animals may exist in societies or groups. They may even perform thinking and problem solving activities, but nowhere in the animal kingdom below man do we have the intimate intercourse, the interchange of references concerning one's own thought, feelings, desires, or the objective happenings occurring in the world, such as we find among the members of the human species.[1]

Language is Bistimulational Behavior

Just what kind of behavior is language? What precisely do we do when we speak? These questions can best be answered by com-

[1] This is not to deny that infrahuman animals perform language responses.

paring linguistic and non-linguistic psychological interactions. The non-linguistic behavior segment with which we are already entirely familiar consists of a mutual operation of a response and a single stimulus. Now by comparison the linguistic behavior segment involves the interconnection of a response with *two* simultaneously operating stimulus functions. Ordinary conversational language we describe as a response to the thing spoken of and the person spoken to. The accompanying diagrams make this clear.

The Non-Linguistic Interaction

$S \longleftrightarrow R$

The Linguistic Interaction.

Referent
(Adjustment Stimulus, or thing spoken of.) S 1

R Reference

Referee
(Auxiliary Stimulus, or person spoken to.) S 2

The thing spoken of we call the adjustment stimulus or the *referent,* while the person spoken to is the auxiliary stimulus, or the *referee.* These two stimulus functions are absolutely essential for eliciting a linguistic response.

Let us not make the mistake of thinking that we do not speak except to some other individual. We can talk to ourselves or to some imaginary person as well as to some object, force, or power. In strictly technical language this means that the auxiliary stimulus function may inhere in the speaking person himself as well as in some other stimulus object. It may also reside in the same object in which the adjustment stimulus inheres, as when I speak to someone about himself.

Linguistic Action is Referential

To speak is to perform a reference-making response to a stimulus object, as when I say, "John is here." Referential action contrasts both with such overt action as picking something up, and with implicit action such as reminiscing about a past event. Speech, unlike effective overt action, does not produce immediate effects in things.

Speech differs from reminiscence in being active accomplishment instead of passive revery.

Though linguistic behavior does not directly produce effects in things it may, of course, do so indirectly. Instead of picking a thing up myself, I may ask someone else to do so. For this reason speech may be called indirect adjustmental behavior.

Speech or referential behavior need not be vocal. Instead of saying "Look at that bird," we can point to it with the same effect. Entire conversations can be carried on without making a sound. Language may be entirely subvocal, or it may be gestural as in the case of mutes.

Mediative and Simple Reference

Language occurs under every conceivable human circumstance. Every possible kind of situation affords us a new occasion for speaking. When this linguistic behavior is intimately connected with other action we call it *mediative*. Language behavior performed independently is simple, or purely *referential.*

MEDIATIVE SPEECH.—There are four ways in which mediate language is connected or associated with other performances.

(a) *Preceding Language*—When I say, "Please sweep my room," I carry out the sweeping performance indirectly by my language response. This is undoubtedly the most intimate connection of speech with other kinds of action. It is this sort of instrumental function, in which language is connected with some kind of work or achievement, that best justifies the term mediative speech.

(b) *Accompanying Language*—Referential reactions may be performed as essential or non-essential accompaniments of other types of performances. When two persons are lifting a heavy object, they not only lift and bear weight, but they may say to each other "it is getting heavier." A single person, too, may be encouraged by telling himself that the work he is doing is coming nicely.

(c) *Succeeding Language*—"Now that's done," is a language reaction we frequently perform after some uncongenial task has been finished. All speech in which we glorify or bewail some event that has occurred is likewise an example of the succeeding form of linguistic reference.

(d) *Substitute Language*—The poor woman who calls out that her child is perishing instead of herself rushing into the burning building to carry the child out, illustrates the substitute type of language. Similarly, the alibis for action we failed to do fall in the same class.

REFERENTIAL SPEECH.—Though referential language is independent of other action it may be just as necessary or important as dependent speech. Perhaps it is equally essential to inform somebody of some kind of event as to tell him to do something. When we recall that much of our education consists of discussing things and events, we need say nothing more about the importance of referential speech. However, since referential language ranges from the frivolity of gossip to the profundity of scientific and philosophical discussion, we see that necessity and importance merely illustrate, but do not characterize independent speech.

There are many reasons for purely referential speech. Such behavior may be performed out of pure sociality, or we may converse because we like to talk to some person, or because convention demands it. Then, too, it may amuse us to perform this sort of behavior.

In still other cases we refer to some object because we are interested in it, rather than in the person spoken to or in our own behavior.

Expressive and Communicative Language

Linguistic behavior is frequently interpersonal. In conversation persons mutually interact with each other; so that the responses of one person become the stimuli for the other and vice versa. Such language is *communicative.*

Linguistic behavior, however, need not stimulate responses in other persons. One can speak to an individual who is absent. Language of this form we call *expressive.* This type need not be further discussed, but communicative language requires additional analysis and description.

In studying communicative language we must differentiate between the transmissive and receptive forms. The former constitutes linguistic action which serves as a stimulus for the language behavior of another person. Receptive language, on the other hand, is a definite response to transmissive language, either of the

vocal auditory type (language heard) or of the graphic visual form (language read).

All kinds of language conduct can be transmissive. Vocal auditory language consists of making sounds by means of our vocal apparatus. Then there is a whole set of activities that we call vocal gestures, such as tonal emphasis and accents, and in general what is popularly described as vocal expression.

In addition there are gestures which are non-vocal that range from subtle facial gesturing to mimetic movements of the arms and hands, including shoulder shrugging, etc. Bistimulational transmissive responses are also performed by writing and in general making signs and symbols of all sorts. If we actually can say anything with flowers or stamps we may regard such behavior as likewise transmissive.

Language is Mostly Conventional

To be effective in social intercourse our language conduct must be conventional. It must be commonly performed by the different individuals concerned. Otherwise the conditions essential to mutual understanding would be lacking. Communicative language especially must be commonly acquired and performed.

The conventional features of language are easily comprehended. Consider formal articulate speech. Whenever we speak our action can be classified as part of some language system. It is either French, English, or Italian, etc. This means in effect that language consists of speaking certain words belonging to a particular vocabulary and subject to certain grammatical organization. Also the pronunciation must be more or less standard if individuals are to understand each other. Thus persons who speak a colloquial dialect in common may converse, but they will not be able to interact linguistically with persons who speak the same language system but with a different pronunciation. It is for this reason that it is sometimes said that British English and American English are two entirely different kinds of language.

Much the same situation prevails when we consider the gestural aspects of speech. These, too, are conventional modes of behavior and readily mark off the speaker of one dialect from another. The gestures of the hand, head, and shoulders are also patterned by group intercourse. Both Parisian waiters and taxi-drivers speak eloquently with gestures but they employ different gestures.

Language as Personal Behavior

The principle of individual differences holds for language as it does for every other kind of behavior. Despite the general conventional character of speech it appears that our language reactions still have this individual and personal aspect.

The conventionality of speech after all refers mostly to the way we speak, but the manner in which we make our references is not by far the whole or even the main part of the response. Besides, even the manner of speaking affords many opportunities for individual variations. Every individual belongs to many different social groups, each of which has its own distinctive linguistic differences. To choose our vocabulary or to slip into legal or scientific speech mannerisms gives a tone of singularity and uniqueness to one's linguistic behavior. An amusing example of such personal vocabulary is the expression of Dana, the author of *Two Years Before the Mast,* who upon returning from his brief sea-going experiences, wrote about "steering a horse." Physicians frequently report that patients at charitable clinics must speak individually of their anatomy and their ills because they never have learned any conventional way of referring to them.

The individuality of speech is further exemplified by the variations in voice quality. Some persons have clear, distinct, and even musical voices; others speak raucously, while still others have what James amusingly termed blotting paper voices. Such individual differences influence the clarity and pleasingness of pronunciation. It is not difficult to divide off those who speak distinctly and evenly from those who mumble, or discharge their words like bullets. Researches conducted by telephone engineers demonstrate that only a minimum of sound is necessary actually to reach the hearer. This fact provides ample basis for variations in the speech of individuals.

Speech style is likewise a fertile source of individual linguistic difference. Some persons speak picturesquely, using many individual gestures and sprightly metaphors, while others speak coldly and drily as though reciting out of a book.

We all know, too, that the pathological and partially abnormal linguistic behavior of persons gives a distinct individualistic character to their language responses. We need only mention the exaggerated hesitancy, dynamic volubility, stuttering, or stammering which marks off particular language adjustments.

When we turn from the manner of speaking to the more distinctly referential phase of speech we probably have even greater possibilities for individual differences. We must be reminded once more that language is a definite psychological adaptation. Accordingly, the person with greater experience in a particular field of human activity can say more about that field and more expertly than others. Whether or not it is true that there are only twelve men in the world who can discuss Einstein's mathematics, the suggestion amply illustrates the linguistic differences between persons.

The question whether we are free in conversing about certain topics or with certain people, or whether we inhibit our linguistic behavior brings us squarely in touch with the problem of individual differences.

In general, when we pay strict attention to the concrete facts of speech behavior and do not merely think in terms of its formal aspects, we find that language reactions perhaps even more than other kinds of behavior, are subject to wide individual variations.

Psychological versus Non-Psychological Language

When we define language as a bistimulational adjustment we do so because of our interest in psychological phenomena. The student must realize that the term language also stands for other kinds of phenomena.

To avoid confusion we must then distinguish between psychological and non-psychological language. The primary mark of differentiation is action. When we are dealing with a thing, instead of a response to a stimulus, we may be dealing with language objects, but not with psychological language.

This is true even of objects which stimulate psychological language. Thus printed or written words in advertising matter or in literature which stimulate speech are not psychological language phenomena although they represent sounds performed in actual language adjustments.

Psychological language may also be separated from things that have never played any part in linguistic adjustments. Such is the case with writings which are merely records. The chronicles of history may stimulate the persons of future generations to think of the greatness and goodness of kings and nations. These materials are products of psychological behavior, but themselves are nothing but things without any connection with linguistic phenomena, unless

they should happen to stimulate someone to speak of them. But if we call them linguistic for that reason, we should have to call everything that we might speak of, linguistic.

There is, however, such a thing as crystallized language—namely, dead language. Thus, non-psychological language may be derived from language behavior, just as the wood of my table was once a living organism. When A tells B something by means of writing, the written material may be regarded as the crystallization of speech. In this sense literature is a descendant of word of mouth reference to important or interesting events. But we must notice that these records are connected with language only as survivals and reminiscences of living speech and not because they are immediate stimuli for our reading responses. Such objects may be called products of living language. They are the results of particular language adjustments, but they must not be confused with the acts which constitute the sources of their origin.

If we must use the name language for both psychological and non-psychological language we might do well to distinguish between them by calling the former functional and the latter morphological language.

Non-Linguistic Psychological Behavior

All verbal behavior is psychological, but it is not always linguistic. There is a wide gulf between genuine referential behavior and the activity of uttering words.

I intend to strike the nail squarely on the head, but instead I hit my finger. We must affirm that the exclamation "Ouch" is a perfect verbal articulation, but is it language? Popular psychology pronounces such vocal utterances to be expressions of feelings. Whether or not this is an apt characterization, such utterances are certainly not genuine language actions.

Psychological language behavior is not merely making word-sounds. There are numerous facts that argue eloquently to the contrary. Consider one from abnormal psychology. Certain pathological persons keep repeating stereotyped verbal forms. For hours on end they continue to mutter series of words, while they keep pacing up and down their rooms. Though this verbigeration consists of definite words we must rule it out as psychological language.

We know that psychological language and vocal utterances are not identical since we can speak without performing vocal behavior.

Our most intimate linguistic responses are performed in gestural terms. We speak by means of manual gestures, facial expressions, and so forth. Moreover, probably in our most important speech behavior, even when we do talk in terms of vocal articulations or words, we at the same time perform gestural behavior, which not only reinforces vocal speech, but also constitutes coordinate conduct along with it.

Symbolic Verbal Behavior

Among the most important of all non-linguistic psychological actions are the verbal responses which are symbolic rather than bistimulational. The making and using of such symbolic responses enable the individual to do things that otherwise would be entirely impossible.

Observe a child who is sent to get an object in the next room. Notice that he keeps repeating to himself "red book," "red book," for he has learned through his past experiences that unless he continues to restimulate himself he might not know for what he came. It is through such word responses operating as substitute stimuli that the performance of many actions is made possible. Such substitute word stimuli serve as behavior symbols for many objects to be acted upon and also for acts that are to be performed.

In adult life we observe the operation of such symbolic behavior in a large variety of situations—for instance, when we add and subtract. By performing such acts we keep informed as to the total we have already reached in the long column of figures we are adding. Without verbal reactions there probably would be no counting at all.

Verbal substitute action is also indispensable for recording things and events. Especially in primitive societies the glories and adventures of the group are recorded and preserved in verbal terms of song and tale. Certain duly appointed men or women of the tribe hand down from generation to generation in the form of oral tradition the records of events, and the wisdom of the tribe. Here vocal behavior serves as do written or printed materials in more complicated societies. Such recording and preservation behavior may be ranged beside the processes of speaking about the events as high points in human behavior.

Naming behavior likewise involves verbal conduct in an essential way. The vocal action in the situation serves as a very effective tool for producing a desirable and important result. Naming

is a process of isolating things from each other and labeling them. It is more; it is a basis for analyzing, abstracting, and summarizing things and their qualities. Symbolic verbal behavior of this kind is an integral feature of thinking and reasoning.

We may conclude that while symbolic behavior may be even more important in the life of the person than linguistic behavior, such conduct is not linguistic.

The Development of Language

The development of speech is a fascinating study, since it constitutes a record of the evolution of psychological personality. Speech development is also an exceedingly important phase of psychology, since its acquisition takes up a large part of the individual's reactional biography. The study of language development, however, is no easy task. In the first place, linguistic behavior acquisition is not only long drawn out but also an enormously complex process. Moreover, since it is performed only upon specific occasions the infant must be kept under constant observation.

Psychologists are nevertheless producing a considerable literature on the subject of speech development. These writings are of two general types. The first consists mostly of word studies. Parents and other observers report the age when their children first utter words, when they make sentences, how long the sentences are, how they can be divided up according to the classification of conventional parts of speech, and finally, how boys and girls compare in their language development.

Instead of following the development of individual children numbers of children can be studied at once. Suitable stimulation in the form of questions can be offered to many children of different age groups, home status, etc., and in this way a great many comparative data can be collected in a relatively short time.

A second type of study consists of observing and recording children's conversations with each other and with adults.

STERN'S SUMMARY OF LANGUAGE DEVELOPMENT.—An excellent statement concerning children's vocabularies is that given by Stern, the German psychologist, in the following summary:

"*Preliminary*—First year. Babble. Imitation of sound forms, first understanding of requests made to the child.

"*First Period*—About 1-1; 6.[2] The child has mastered a few sounds used with special meanings, which must be considered sentences of one word. Speech-elements so far show no understanding of grammar or ideas (conceptions) and their significance, no differentiation as yet between the objective and what touches will and emotion. In sound they are still near to babble—the natural symbols; word-pictures and active sound-expressions are most prevalent.

"*Second Period*—About 1; 6-2; 0. Awakening of the consciousness of the object of speech (that everything has a name) and the will to master it. The vocabulary suddenly shows great increase; questions appear as to the names of things. About the same time the stage of 'one-word sentences' is left behind; two, soon, several words are combined, first hesitatingly, then more and more fluently in a complete sentence. Vocabulary contents are increased first by nouns, then by a large addition of verbs, and lastly by qualifying words and those expressing relation. Stages of substance, action, relation and distinction.

"*Third Period*—About 2-2; 6. Complete mastery of uninflected speech. The child learns to express the finer shades of ideas by modifications of words, and about the same time different forms of inflection (conjugation, declension, comparison) begin to develop. Sentence-formation, although still in paratactic form (simple sentence), is very varied. Series of sentences—exclamations, descriptions (statements), questions—are formed. Questions refer to names of things, where, what, information and personal sympathy.

"*Fourth Period*—About 2; 6 and on. The purely paratactic sentence-formation is left behind. The child learns to express varying order of thoughts (principle and subordinate) by hypotaxis, and there is rapid growth of the different kinds of subordinate clauses; although the finer differentiation of particles and the mastery of the harder verb-forms (e. g. the conjunctive or subjunctive) may yet require a considerable time to learn. The child's questions begin to extend to time and, above all, to the causal relations (why). Tendency to independent word-formation in compounds and derivatives."

As this summary indicates, word studies have to do more with conventional verbal action than with speech behavior. This ex-

[2] Read 1 year to 1 year 6 months.

plains why the summary bears the appearance of a fixed and uniform unfolding of language actions. This definite beginning and development are not found when language is not limited to vocal speech. Language adjustments are much more subtle and begin long before children perform highly coordinated vocal or other conventional action. It is for this reason that the view has developed that language starts not as words but as gesture. That the language behavior of infants begins before they perform conventional verbal action is indicated by the fact that even at fairly advanced ages children often speak their own vocal languages so that nurses and parents must learn them.

Allport's Outline of Language Development.—(1) *Prelinguistic Stage*—This consists of gestures such as head shaking or tugging at the hands or clothing of an adult, which Allport believes proceed vocal expression. Along with gesture development comes laryngeal expression such as crying. Here the vowels develop.

(2) *Stages of Actual Language*—(a) According to this author the first level of actual speech consists of developing various random articulations which overlap the laryngeal expressions. Allport assumes that at this stage begins the process of pronouncing the consonants of the language. These sound-making reactions are fixated by self stimulation. Hearing himself say "da" the child repeats it and thus establishes an auditory-vocal habit.

(b) The articulate elements developed in the first stage are now stimulated by other individuals. The child can then repeat what he hears. When someone says "doll" to the child, he repeats his own "da."

(c) In the third stage the articulate elements which have been evoked by others become conditioned and are attached to objects and situations. Thus when a person shows the child a doll and says doll, the child attaches the response to the doll. This stage the author thinks of as the naming stage. Even though the child still pronounces words imperfectly he can learn the names of several hundred objects.

(d) According to Allport the final achievement of linguistic development is a response to language by means of language, as in

answering a question. This stage he thinks occurs only after a fair mastery of speech has been obtained.

Allport's description of language development fits in many ways the actual linguistic reactional biography, although as in the case of Stern, the development is regarded as too definite and inevitable. It is highly questionable whether gestures, vowels, consonants, words, and sentences are actually acquired in such fixed succession. Allport is apparently influenced by the concept of signs. For this reason he makes gestures a distinct elementary stage of development, as though language consisted only of formal words connected in sentences. The notion of signs also explains why this writer places so great an emphasis upon the influence of other persons in language. For persons play their largest part in the child's language development when he learns conventional words.

Piaget's Studies of Conversation.—Speech development can probably best be studied by observing the spontaneous conversational or interpersonal behavior of children. Piaget, the Swiss psychologist, has made some important studies in this way. One of his conclusions is to the effect that the language of children even as old as five years is to a great extent, in fact as much as 50%, egocentric; that is, they speak in the form of a public monologue, disregarding other persons. In other words, their language is primarily expressive. But all scientific results depend upon the technique by which they have been obtained. Katz quotes other observers who assert that Piaget's estimate is much too high. They claim that children's language is not characteristically expressive, but equally communicative.

The fact that children do perform considerable expressive language responses certainly confirms the belief that language is not symbolic. They are referential reactions which may or may not be addressed to another individual. It is quite probable that language occurs so early in the life of the child that the symbolization of things and actions cannot be presupposed. As Katz, himself a keen observer of children's language development, points out, children cannot understand each other as well as the parent can understand them.

Language behavior development is no fixed or cut and dried process. Like all psychological phenomena it depends upon a number of particular conditions. The type of family, kind of home,

number of contacts with children and adults, the interest of parents, all have their effects upon the course of the individual's language development.

Conventional and Personal Language Development

Word development is the acquistion of formal or conventional language, while language adjustments consist of personal linguistic behavior. The former requires quite a different form of development than the latter. Conventional speech to a great extent must be acquired by special learning techniques, whereas genuine language is developed as a matter of course as a necessary adjustment to surrounding things.

Children develop conventional verbal language as a hierarchy of behavior acquisition. Most psychologists agree that the first level consists of learning to name things conventionally. This is to a great extent a process connecting articulated words with objects. The child is faced with a problem of pronunciation, to produce articulate words that sound the same as those of its elders. Psychologists differ as to the details of this development. Allport seems to believe that complete conventional word actions are developed as more and more perfect physiological performances. The present writer believes, however, that word actions are entirely new behavior configurations developed by merely repeating what other persons do. Certainly, conventional language responses are already performed by the parents. The child learns to do as others do in linguistic situations exactly as he does in the craftsman situation when he uses a hammer instead of a chisel to drive a nail. While all behavior development must occur in terms of the child's actions, such actions are not the mere elaboration of his physiological functions (vocal reflexes), but rather general interactions, with existing things and acts as stimulus objects.

The same processes of interaction operate in the development of more elaborate patterns of conventional referential responses. The child builds up responses as phrases, sentences, idioms, and series of sentences. All this language behavior is at first definitely of the family type of dialect but later becomes affected by the dialect of the larger units of the community and nation. By this time the observational activities of the individual yield him a rich harvest.

Genuine language adjustment can be performed in many ways. The use of conventional words and phrases is only one. Stern cites the case of Stumpf's (German psychologist) son who for two years stuck to the vocabulary which he had himself developed. "With these he formed in royal fashion all possible word compounds, long sentences, and series of sentences giving entirely the impression of a foreign language." This type of language adjustment illustrates a middle stage between purely personal forms of language adjustment and the completely conventional patterns of dictionary words.

In the development of conventional language the child's action is holophrastic. The utterance of single words constitutes complete adaptation. When the child says "hat" this so-called word is equivalent to what is conventionally called a complete sentence. At this stage it is the child's way of saying, "give me the hat" or "take the hat" as the case might be. In this connection observe therefore that when the child says "hat" or "dog," it does not mean that he learns nouns first or in greatest number, but rather that his language adjustments from the standpoint of words are undifferentiated and unelaborated.

Linguistic Learning

Conventional language learning consists largely of the conditioning type. To illustrate, the child is shown an object and repeats the word that is spoken in connection with it. A glass of milk is pointed to and the nurse says "milk," which the child repeats. After a certain number of such stimulus presentations and vocal repetitions the child says the word whenever the object is presented.

But where do these word acts come from? Of one thing we may be certain. They are not the natural unfolding of laryngeal processes. Rather, they are developments from contact with speech performances of other children and adults. Conventional language behavior exists before any particular child is born. In general, we may say that although these actions are the inevitable performances of a biological mechanism or organism they are cultural phenomena.

Linguistic learning is not limited at all to conditioning. Many speech acquisitions are of the original S⟷R coordination type. For it is clear that the child must connect verbal or gestural references with the original stimulus objects in the first place. Since theoretically all conditioned learning must be preceded by the orig-

inal S⟵⟶R process it is not unlikely that much linguistic learning consists of both processes at once.

Other learning forms are not excluded either. On the whole we must regard the development of language as a complicated process in which all the various forms of learning cooperate with uncontrived behavior acquisition to enable the individual to adapt himself linguistically.

Behavior Configurations in Speech

Probably the first attempt to describe a behavior configuration with the possible exception of a simple reflex was that of speech. Speech has always been regarded as a series of sound producing actions. It follows therefore that the general behavior mechanisms of verbal action are very excellently described.

Among the details of such description is the story of how the lungs acting as a pair of bellows force air through the trachea,[3] at the upper end of which is located the larynx (Figs. 66, 70). The larynx is essentially a box made up of cartilages activated by muscles. The working of these muscles changes the general shape of the larynx including the muscles called the vocal cords,[4] which constitute the roof or top of the box. The air coming through the trachea passes through an opening between the cords which is called the glottis (Fig. 69).[5]

Vowels or musical sounds are produced when air passes through the glottis, vibrating the cords. Of the several characteristics of a vowel sound, the pitch is believed to be influenced by the length and tenseness of the cords, which affect the frequency of vibration. By such glottal vibration the human larynx is capable of producing tones with a range of from 2 to 2½ octaves. The qualities of these vowel sounds are also thought to be affected by the various shapes assumed by the vocal cords, and by the various resonating head cavities.

Consonants or noise sounds are produced in the mouth or nasal cavity by various interferences with the air current. What stu-

[3] It must be mentioned that while the sounds of the European languages are for the most part expiratory, the language of the Hottentots and Bushmen frequently employ inspiratory sounds; namely, the clicks produced by sucking in air.

[4] In view of the fact that these structures are really not cords, but wedges, writers prefer the names glottal lips, vocal wedges, or vocal shelves.

[5] For a description of the larynx see Chap. 23.

dents of language call consonants consist of such noises, either pure or mixed with laryngeal tones.

Phoneticians have built up many theories concerning the exact positions and actions of the linguistic structures necessary to produce the various vowels and consonants of a language. For example, the vowel "a" as in father was supposed to require a widening of the mouth and a depression of the tongue as compared with "e" in eve. In order to produce the former the tongue had to be raised and the mouth closed. On the basis of these changes in the sound producing and modifying organs students of language built up all sorts of classifications of what they called the elements of speech. Vowels have been divided into (1) high or open, (2) low or closed, and (3) intermediate sounds. Another vowel classification is that separating the front sounds, made by raising the top of the tongue (English long e and a), from the back vowels in which the back of the tongue is raised (English oo and long o), and both of these from the mixed vowels produced by raising the middle of the tongue or by combining front and back sounds.

In order to summarize the alleged facts of sound production, or the behavior configuration of sounds, phoneticians have built up elaborate classifications of consonants. We can illustrate these classifications by examining briefly four kinds of consonantal arrangement.

A. Based on Kind of Sound Interference.
- (1) Fricatives, spirants, or continuants.
  Examples, f, v, w, s, sh, th.
- (2) Plosives, explosives, occlusives, stops.
  Examples, p, b, t, d, k, g.
- (3) Affricates (plosives and fricatives).
  Examples, ch, pf.
- (4) Trills.
  Example, r.

B. Based on Organs of Articulation.
- (1) Bilabials (both lips).
  Examples, p, b, w, m.
- (2) Labio-dentals (lower lip, upper teeth).
  Examples, f, v.
- (3) Pre-dentals (tongue and teeth).
  Example, th.
- (4) Alveolars (tongue and teeth ridge).
  Examples, t, d, s.
- (5) Palatals (tongue and hard palate).
  Example, y.

(6) Velars (tongue and soft palate).
Examples, g, k.
(7) Uvulars (tongue and back soft palate).
Example, Continental r.
(8) Laryngeals or glottals (closing of glottis).
Example, h.

C. Based on Place of Articulation.
(1) Orals (air through mouth).
(2) Nasals (air through nose).
Examples, n, m, ng.

D. Based on Presence or Absence of Voice or Laryngeal Sound.
(1) Voiceless, surd, or breath sounds.
Examples, p, k.
(2) Voiced, sonant, or vocal.
Examples, b, g.

Let the reader beware. All these classifications or descriptions of speech configurations are really convenient abstractions. While it is true that one can analyze out such sounds from the complex vocal behavior constituting a language, the converse is not true. Language behavior does not consist of words, compounded out of such sounds joined together into sentences. We must conclude that however useful these classifications may be in teaching foreign language behavior, they are not descriptions of how one speaks. The consideration of several points must strengthen this conclusion.

In the first place, the actual sounds we make are always phases of particular patterns and are conditioned by their interrelationship. The pattern is the primary factor. The "t" of tune is different from the "t" of sting, while the two r's in river are quite unlike.

Secondly, the experimental techniques developed by phoneticians in recent years for studying sound-making processes lead to the conclusion that linguistic sound behavior is a complicated continuous activity and not the stringing together of fixed sounds. We have already quoted Meader (Chap. 16) who says that "it is impossible for an individual to repeat a given speech movement at will in exactly the same way in which he has previously performed it," and "it may be seriously questioned whether one ever makes the same group of speech movements twice in a lifetime."

By the use of x-ray and other methods Russell has demonstrated that linguistic sounds need not be produced in the way teachers of language have always supposed. Especially the vowel triangle, which every student of foreign language knows, is now under sus-

picion if not entirely exiled. The implication of these newer phonetic studies is that the different sounds of a language can be produced in various ways.[6]

Thirdly, even spoken language does not consist entirely of sounds. Accordingly, to describe language configurations accurately we must consider the indispensable place in them of the facial, head, shoulder, and other gestural movements, for they are no less a part of vocal speech responses than the sounds made. Linguistic behavior is never such an extremely localized affair as the above description seems to indicate.

Finally, we must never forget that all psychological activity must always be described as a total adjustment. This means that the stimulating conditions must likewise be taken into account. In actual conversation we do not in any sense utter with any precision, series of sounds to be heard precisely by other persons. We perform referential adjustments.

Theories of Language

Throughout this chapter it has been evident that descriptions of language are always based upon some theory as to its nature. This was especially clear when we discussed the studies of language development.

The bistimulational theory used in this book is rather new. The following two prominent doctrines have always dominated the linguistic field.

(a) Language consists of physical words or physiological acts which express ideas. The student will recognize at once that the expression theory is a clear cut instance of the mentalistic viewpoint. This theory entails serious difficulties. In the first place, here as in every other phase of psychology it is impossible to establish that psychological phenomena consist of ideas or mental states which are translated into or correlated with physiological or bodily action. How can mental states be connected with words or verbal actions?

In the train of this difficulty comes another. According to the expression theory, vocal or other speech behavior is not regarded as psychological but merely as expressions of psychological action. Even if the psychological actions which are presumed to be

[6] Parmenter and others dispute Russell's findings. See references under Larynx, Chap. 23.

expressed are regarded as actual responses to stimuli this conception seems to be very far removed from the actual facts of language.

(b) Language consists of words that are symbols for ideas or things. When we study language as actual responses there seems to be no reason to look upon it as in any sense symbols. Actions are adjustments and in many cases the person may speak to himself so that symbols are entirely out of the question. But what of the person who listens to the speech? When I say, "Take off your hat," is not my word "hat" a symbol for the hat which you are to take off? According to our view, the action here is a stimulus merely, as in any other case. Now is it proper to say that the coin that I perceive in the road is a symbol for me to pick it up? And yet it might be argued that language stimuli are different, that the word is so different from the object with which one is to interact that it must be regarded as a symbol. The retort might be made that when the dog in the conditioned reaction experiment reacts to the bell, as it does to meat, there can hardly be any greater difference between the two objects, and yet it is entirely gratuitous to call the bell a signal for the meat. If we do, we are merely calling all accessory and substitute stimuli, symbols.

Of course, there are such things as language symbols. For example, written words may be for the reader symbols for the speech reactions that would be performed in his presence. And certainly printed words are often symbols for things, but we must not confuse these objects with the actual behavior which comprises linguistic adjustments.

Origin of Language

How did language originate? Since this has always been a puzzling question it is not strange that language has been looked upon as a very mysterious phenomenon. In the early days of psychology scholars took the attitude that language was (a) a faculty of the mind, (b) a technique of action, and (c) a series of words with particular meanings.

Before the theory of evolution became widely accepted it was seriously suggested that the faculty of language was a direct divine gift. Those who regarded language as a technique of action thought it was invented by an individual and then transmitted through all the later generations. The proponents of the third view dominated the field for a long time. These language scholars became divided

into camps because they explained in different ways how words took on certain meanings or how they came to symbolize certain things. The most naive of these explanations was that words got their meanings from the agreement of savages to use certain sounds as names for things. Three other theories of this third type are still widely recognized.

(1) ONOMATOPOEIC THEORY.—According to this doctrine, words imitate some characteristic sound of the objects they represent. The classical example is the child saying, "bow-wow," when referring to a dog. In support of this viewpoint, nicknamed the bow-wow theory, writers have collected a number of words such as buzz, choo-choo, hiss, bob-white, and bumble bee, which they claim exemplify it.

(2) INTERJECTIONAL THEORY.—This viewpoint, called the pooh-pooh theory, presupposes that language arises from the fixation of naturally emitted sounds which originally express feeling, such as "oh," "ouch," and "pshaw." The inventors of this theory claimed that the resemblance between interjectional words in various languages was a strong point in its favor.

(3) NATURAL EXPRESSION THEORY.—It is implied that certain objects or situations force individuals to utter certain sounds which seem to be appropriate to such stimulus objects. This theory has been nicknamed the ding-dong theory because it implies that man is a bell which can be rung. The proponents of this viewpoint believe that originally a comparatively few sounds were so rung out and that these constitute the roots from which all language developed.

Such theories can hardly be called explanations of language. Even in the last three, which alone can be seriously considered, lies imbedded the assumption that language consists of word-things, that is, names. The only suggestion that language is human behavior is that the names are vocally pronounced. In none of them is there even a vague reminder that language is a complicated form of human adjustment.

With the rise of the evolution theory a decided change came about in linguistic conceptions. For one thing they became more naturalistic. Students of language gave up the idea that words were merely signs for thoughts, meanings, or things. They began

to emphasize adaptational action. Those who sought for the origin of human speech believed they could find it in the evolution of animal cries.

Wundt, who most elaborately developed this evolutionary theory, supposed that human speech evolved from emotional expressions. Vocal actions were regarded as gestures along with other movements or actions. Now when these movements are made by several animals living together they develop a process of interchanging gestures. Emotional expressions of one are sympathetically repeated by others. Later, animal A, observing animal B perform an expressive act, concludes that B is having the same mental experience A has when it performs a like act. Thus expressions take on ideational significance or meaning.

Human speech then develops in a process of social evolution. Complicated language behavior has evolved through what Mead aptly calls the conversation of gesture.

It is an appealing hypothesis that the complicated phonology of formal verbal speech is an evolution from animal vocalization, but does this explain the origin of language?

No more can be claimed for this theory than that it attempts to explain language as a general faculty in terms of actions. But is language a general faculty? Is it not rather specific adjustmental action? Then too, it is questionable whether language is evolved from physiological activity. Although language is always action there is no reason why speech cannot be regarded as originating entirely in human intercourse. In other words, speech no more than any kind of custom or social habit evolves from physiological action. This possibility of conventional language evolution must not be left out of account.

Again, it seems to be assumed that language consists of physiological actions with meanings tacked on. That is, the actions which are originally physiological take on meanings. Does language begin this way? As opposed to this view we suggest that language consists of behavior that arises as appropriate adjustments in specific situations. Just as human organisms developed ways of getting across streams by single or joint action, so they have developed forms of joint reference to things.

How the individual comes to speak in a conventional way is simply a matter of taking on responses similar to those performed

by the older members of the family and other groups. The fact remains then of the child learning the meaning of words. This is the same process as learning the meaning of words in a foreign language. In this case it is quite true that the words are things and in this sense are really philological phenomena and not psychological language.

How then does language in general originate? Frankly, we do not know and in our opinion speculation is more or less futile. It is impossible, of course, to come into possession of actual data concerning developments which took place aeons ago. Most speculation concerning language overlooks an infinite number of anthropological occurrences which are indispensable factors in the development of speech.

From a scientific standpoint, the origin of language really is a study of the actual changes which take place in the conventions of speech. For example, it is possible to trace the derivation of the French language from the series of complex factors which include vulgar Latin, German, and Celtic. But here we are drifting away from psychological phenomena and moving into the field of philology.

CHAPTER XX

VOLUNTARY AND OTHER COMPLEX INTERACTIONS

Voluntary Action Occurs Under Complex and Equivocal Circumstances

The hour had struck. Robert E. Lee had to face a serious dilemma. On the one hand, even though he was to be sent as the commander of an army to invade his beloved South, he was stimulated to continue in the service of the nation which had trained him, to which he had within the month repeated his oath of loyalty, and in whose army he was a colonel. On the other, was the stimulus to resign his commission in the United States Army and take up arms against his country, while he disapproved of the secession of his native Virginia.

This example of behavior illustrates the circumstances of voluntary conduct. The situation is not always so serious nor fraught with such grave consequences. But in every instance of voluntary behavior there are varying possibilities of action. There is likewise a conflict to be resolved by suppressing one of two competing behavior segments in favor of the other. This means that the voluntary situation is always complex and equivocal.

Why did Lee embrace the cause of the South rather than that of the North? Here is the fundamental problem of voluntary action—namely, what are the conditions which lead to one type of action rather than another? It is clear that such behavior situations involve more than a simple stimulus-response interaction. It is now not a mere matter of acquiring and performing a response in connection with a single stimulus function. Rather it is the question, which stimulus function and which action.

The competition between the alternative behavior segments in our Lee illustration appears to emphasize the actions rather than the stimuli. But there are other cases of voluntary conduct in which

the stimuli rather than the actions seem to clash. When a Vermont farmer faced the issue whether or not he should answer Lincoln's call for volunteers the question was, shall a certain stimulus object—namely, the call for volunteers—be responded to positively or negatively? This is, of course, an instance in which there was just as much an alternative between two behavior segments, but here the situation involved merely the furthering or checking of what is socially a single action.

Voluntary Action One of Three Levels of Behavior

Voluntary Level.—All behavior can be divided into three levels. At the top we place voluntary action, which, as we have seen, is complicated by a conflict. Now whenever there is such a conflict the acting person seems to stand out as a controlling factor in the behavior situation. He has to resolve the dilemma. This means that there is more than a single response operating. The whole personality may be involved with all one's hopes, ambitions, sorrows, and sense of duty.

Involuntary Level.—Anyone who has been embarrassed by not being able to check a sneeze in church knows what it means to be out of control of one's behavior. This type of action, characterized by an inevitability of performance as far as the person is concerned, is the lowest of the three levels. Even behavior which the person himself disapproves of and would not do if he could help it, occurs, as though to spite and torment him. Such action is seemingly imposed upon the performer.

Inability to resist temptation is another case in point. The person acts not as he would, or knows he should, but as the stimulating objects demand. Another example is being taunted into some form of behavior, as indicated by the words of Cassius.

> Do not presume too much upon my love;
> I may do that I shall be sorry for.

The more serious instances of involuntary conduct are the abnormal actions called impulsions and compulsions. The impulsive individual is one who, when he comes upon a certain stimulus object, invariably performs an action though it may embarrass him and even cause him serious social maladjustment. The kleptomaniac does not need the object he takes and may have plenty of

money to buy it if he did, but the object seizes hold of him and he must act.

The literature on abnormal psychology contains a number of descriptions of unfortunate individuals who are so overpowered by stimuli as to persist in the desire to kill even one of their most beloved friends or relatives despite themselves. There is the striking case of Glenadel,[1] a French peasant, who at sixteen years of age developed the incessant idea of killing his mother, whom he adored. To prevent this terrible crime he was allowed upon his own plea to enlist in the army. But even then he was haunted by the thought of deserting in order to carry out his murderous act.

Those who suffer from abnormal cravings display classic examples of domination by stimulus objects. Food placed before such persons cannot be resisted. Drunkards must have their liquor no matter what is necessary to procure it; drug fiends will steal or even kill in order to obtain the drug they use.

NON-VOLUNTARY LEVEL.—Between the two levels just discussed there are actions which do not show any emphasis of either person or stimulus. When the stimulus appears the individual acts at once without any difficulty or any reference to consequences. There is a car ahead of you on a clear road and you simply speed up a bit and pass it. Such is the case in contingential action. There is no question here of control or lack of control. The individual is equipped with a reaction system and when he comes into contact with the appropriate stimulus object he promptly and smoothly responds to it. Habits illustrate the same principle. As we have seen in Chap. 16, habits are behavior segments in which responses and stimuli are so closely integrated that the activity occurs automatically. When we meet an acquaintance we mechanically utter "Good morning." At ten minutes to nine the student customarily starts for the class room, while at noon he just as regularly proceeds to his luncheon. All of the great numbers of conventional or social responses fall into this class or level of non-voluntary action.

Various Circumstances Complicate Willing Conduct

Since the fundamental fact in voluntary behavior is the choice of conduct, the conditions influencing or determining such action

[1] Quoted from Calmeil by Ribot, The Diseases of the Will, Open Court, 1894, p. 59.

take on a very great importance, and often introduce very serious complications in voluntary situations. In Chap. 2 we have seen that psychological behavior is influenced by the settings of stimuli and by the background of the total interaction, but these conditions do not in any way complicate the individual's behavior. In fact, they frequently serve to forestall behavior complications.

By contrast with the ordinary "settings" of behavior, the conditions of voluntary action constitute very special behavior circumstances. Thus in our Lee illustration what made the whole situation so significant was its complication by a conflict of loyalties which could only be occasioned by such an unusual circumstance as civil war.

Sometimes voluntary action is set against a background in which personal beliefs and professional ideals do not square with the laws and conventions of society. A doctor assisting at the birth of an infant discovers that the child is so hopelessly deformed as to be biologically defective and psychologically an idiot. The doctor must therefore face the alternative of acting upon the basis of his private beliefs and ideals, which stimulate him to put the child out of its misery and forestall its becoming a burden to its parents and possibly a charge on society, or of abiding by the law and public opinion which decree that all life must be preserved.

When the officer and men of a firing squad must resolve the conflict of either acting counter to their ideals of justice or violating the obligations that military discipline imposes upon them, we have a behavior complication arising from the opposition of a duty and one's own traits. The biblical story of Jephtha and his daughter constitutes a dramatic illustration of a conflict between fulfilling a vow as a self-imposed duty and the feeling reactions aroused by the need to sacrifice one's own child.

The consequences of doing one thing rather than another serve as potent complications of voluntary behavior. It is about time to buy that suit I have been needing, but if I do, then I won't be able to contribute to the Y.M.C.A. drive which comes this month. Law students bewail the fact that only severe consequences in the form of legal penalties make automobile drivers choose to avoid blocking traffic. In *Luke 18* occurs the parable of the judge who determined to dispense justice to the widow not because he feared God or respected men, but because as a consequence of not doing so he would be worn out by her pleas. Voluntary behavior situations

become very complicated when there is a fine balance between the consequences of several acts. Hamlet's famous "to be or not to be" offers a vivid illustration of this type of situation.

Mere likes and dislikes or even casual inclinations can complicate behavior situations and thus make necessary the resolution of an alternative. Here the circumstances are neither serious nor are any untoward consequences involved. A person may regard it as advisable though not necessary to attend the governor's reception, but this involves meeting slightly undesirable political personalities; so that while no harm is done one way or the other, one response must be inhibited in favor of a different one.

Personality Traits in Voluntary Action

To discover why one line of action rather than another appeals to the person, or why two lines of action seem so equally worth doing, we must examine the individual's personality development. It is there that we find preference equipment, likes and dislikes, ideals and ideas which figure so prominently in choice situations and which form the bases for behavior conflicts. Why do we subscribe money to a foreign mission instead of buying that new camera we want? Because we have developed the belief that great good is being done in that field. While men differ in their motives for enlisting in the army rather than remaining in their present comfortable berths, you can easily trace back the determining influence to some of their personality traits. Some are equipped with the belief that the army is fighting in a just cause; others are too cowardly to do otherwise; while still others find in war an outlet for whatever spirit of adventure they have built up.

When the student faces the choice of preparing for the coming quiz or accepting his roommate's invitation to attend a dance, one or the other stimulus will prove the more attractive by weight of his personality traits. Among such personality conditions may be mentioned ideals, a sense of values, obedience, loyalty to scholastic ideals, likes and dislikes, and habits of easy acquiescence.

Cultural Conditions in Voluntary Action

To a great extent, voluntary action is complicated by the cultural or civilizational life of persons. This cultural environment supplies the basis of conflicts. Where but in the conflicting demands of our

social life do persons build up loyalties and obligations which later result in a clash of motives? The social surroundings of the individual force upon him conventions which complicate his behavior by bringing problems into it. When conventions dictate on the one hand that a man should die for his country and on the other that he must preserve himself, we may expect behavior conflicts. Nevertheless, when to do honor to the emperor is one of the highest duties of man, as it has been in Japan, it is easy enough to commit hara-kiri rather than to preserve one's life as most other social codes demand.

Psychological and Social Willing

If I hold a pistol to your head and demand that you go out and rob a bank, the law will not penalize you for this action. The common law as a social agency does not hold you responsible for actions performed under duress, just as though such behavior were done against your will. From a psychological standpoint, however, such an act is not involuntary but definitely voluntary. The person is here faced with two stimulus-response situations and because of his personality equipment he chooses to rob rather than to die. From a psychological standpoint it makes no difference how difficult the situation is made, how cruel the motivation may be. Such an activity must still be regarded as a voluntary act. We see then that there is a sharp distinction between voluntary action in the social and the psychological sense.

Deliberative and Non-Deliberative Voluntary Action

Shall I buy this hat or the other? The choice has narrowed down to these two, but both are equally desirable. How can the alternative stimulation be resolved? Well, there is the old reliable method of tossing a coin. Surely such a trivial dilemma does not require any more elaborate method. Then, too, I might merely ask someone else what he thinks about it. The opinion of this person, even a stranger, is the determining factor in the situation. This is non-deliberative voluntary action.

But the situation is far different when the alternatives are either to matriculate at a highly desirable but expensive college, or to attend a patently inferior one with less sacrifice on the part of one's parents. In such a case it may be essential to perform simple or elaborate deliberative actions before one can perform the final ad-

justment. When voluntary situations involve serious consequences or clashes of principle they require thinking and problem-solving action before they can be carried out.

Motives as Factors in Voluntary Action

That voluntary action involves some sort of conflict has long been recognized by psychologists. They have not, however, regarded this conflict as a competition between alternative stimulus and response interactions (behavior segments). Instead, they have described voluntary conduct as a conflict of motives. Clashing motives undoubtedly do precipitate voluntary behavior. But what are motives? The older psychologists unfortunately regarded them as some sort of internal driving force or power. Motives thus were looked upon as a kind of absolute action principle—internal causes or producers of action. The present writer holds, however, that motives are really interactional factors. This view appears plausible when we examine a few of the historical suggestions concerning what activates human behavior.

Instincts and Drives.—While discussing native behavior we have already had occasion to investigate the problem of internal forces. We saw there that psychologists thought of instincts as mental forces of some sort or biological conditions which made people act in some particular way. Instincts as mental or psychic forces have become suspect. The biologically-minded psychologists have attempted therefore to translate these drives, as they began to call them, into tissue needs. Why does the organism eat? Why, indeed, but to satisfy hunger. Why does the organism drink? The answer follows that tissues call for water. Why do persons mate? Because the sex organs function.

Now like all serious suggestions this notion of drives has truth in it. The satiated person does not eat as a rule. But where is the drive of hunger? Do we eat merely because we are hungry? The constant attendant upon banquets seems to eat only in order to ruin his digestion. Was it tissue needs that prompted the Romans to regurgitate their food in order to eat more? Tissue needs do activate us to drink water when we get down to the biological level. But how much drinking is on this level? How much of human drink is water?

Why not consider hunger contractions as stimuli for the action of looking for food, and the dryness of the throat as a stimulus for

finding water? When food and water are found they stimulate us to eat and drink if they are of the right kind; otherwise we reject them. Drives then turn out to be stimuli. But hunger and thirst are also organic conditions which determine how we shall act with respect to things. Also they are often deterrents to action, but in either case they are hardly drives. To say food and sex are the great drives of human behavior as some psychologists do is a fair statement when taken in a metaphorical sense. It is as true as the adage that money is the root of all evil. But as a scientific pronouncement it carries very little weight. To account for all human action by saying that persons are activated by hunger and sex is to get away from the actual facts of human life.

Springs of Action.—Another familiar conception is that of springs of action. Ethical writers, especially, attempted to explain human behavior by saying that men are activated by the desire for pleasure and the aversion from pain. This view too has some truth in it. We undoubtedly do various things in order to avoid unpleasantness or to achieve pleasantness. Pleasantness and unpleasantness are facts, sometimes operating as stimuli; at other times they are properly regarded as conditions of behavior. But they are certainly not springs of action in the sense of internal forces.

Psychoanalytic Motives.—In recent years the Freudian psychologists have popularized the conception of motives as determiners of conduct. When you return from a visit to your friend's home you discover that you have left your gloves. There is, say the Freudians, a hidden motive for your behavior. You have left your gloves so you would have a reason to return. The physician cannot recall the name of his long familiar patient because he once wrongly diagnosed his case. One might well criticize this notion of special and inevitable motivation. Why should one resort to such intricate manoeuvering to revisit a home where one is always welcome? Furthermore, it is no rare occurrence for students to leave articles in the Dean's office where they have reluctantly gone to answer an unavoidable summons. Despite such criticisms there undoubtedly are such motivating conditions determining the performance of particular actions. But since there are always conditions to account for our actions it seems supererogatory to make the former into peculiar causes of psychological happenings.

Motives are either Stimuli or Behavior Conditions

We conclude, therefore, that what are called motives are sometimes stimuli. Such is the case when it is said that hunger is the motive for theft. Otherwise motivation is simply some condition of behavior. In this sense motivation is certainly a fundamental psychological fact. All the different influences upon behavior consist of concrete conditions of action in the sense explained. It is entirely proper to speak of hunger as the motive for theft, but this means nothing more than that a person who ordinarily would not stoop to such action has his resistance to temptation lowered by hunger. We must not forget, however, that some people steal merely for the fun of it, or for any number of other reasons, while on the other hand, there are many people who would rather starve to death than go counter to their early character training.

Intentional Behavior

The prisoner at the bar admits that he fired the shot which resulted in X's death. He, however, disclaims all responsibility for the action, and claims that he deserves no punishment, for he did not intend to kill the man. In legal terms, he disclaims any malice aforethought. In support of his contention he asserts that he thought the gun was not loaded. What kind of psychological fact is intention?

In the older mentalistic writings this intention was regarded as some kind of mental process, an "idea" which was in the "mind" before the overt act of shooting. The question then was whether the shooting was preceded by the idea of killing. If so the prisoner meant to commit murder.

Today intentional behavior must be differently described. For one thing, as we have seen in Chap. 10, we no longer conceive of ideas as psychic states, but rather as interactional processes exactly as in the case of every other psychological phenomenon. Then, too, intentional behavior is in no wise so simple as the older psychologists believed. Besides ideational behavior it involves many other activities and traits.

As soon as we consider the intention to commit a murder we must examine the stimuli for such action. We find that it is only particular individuals who can be stimulated to desire the death of someone, or who are willing to commit murder. It is only the

person who has not developed an attitude or belief opposed to revenge or slaying who will intend to punish the wrong doer. There are undoubtedly still fewer people who can be stimulated to intend such an act by the desire to acquire some of the property of the victim.

Intentional behavior, then, involves the possession of certain sorts of personality traits which favor a particular kind of performance. Such traits may be general, as when the burglar is bent upon shooting anyone who interferes with his activities, or specific, exemplified by the person who only under very extraordinary conditions can be worked up to the pitch of discharging a weapon at someone.

Intentional behavior also involves technical capacity to carry out an action. It is unreasonable to accuse a man of intending to fly off with one's airplane if he has no manner of knowledge of flying machines. Still there is an interesting point to be considered here. When a person is known to have acquired traits of foolhardiness or bravery he may set himself the task of doing impossible things.

Our understanding of intentional behavior might be furthered by comparing it to unintentional behavior. Unintentional conduct is no special kind of action. The term unintentional is a negative one; it merely refers to the absence of intention on the part of the performer. In this sense non-intentional behavior may be equated with non-voluntary conduct, which also suggests the absence of some kind of activity, but does not inform us concerning what kind of action is taking place.

Intending and Planning

How does intending differ from planning? Apparently there is some resemblance between the two, however superficial it may be. Planning, as we have seen in Chap. 10, is a specialized type of thinking activity. Intending behavior, on the other hand, is the development of an attitude of acquiescence, or entertaining a decision to carry out some particular act. Planning is a process of performing an action in anticipation, as when the mechanic draws his blue prints to guide him in constructing a certain object. Planning is thus an active preparation for future action.

Intending to do something, on the other hand, is an interaction by itself—one, namely, in which a determination is developed. Intending to perform an action and then doing so, means that the

individual is engaged in a very complicated behavior situation. In contrast to planning, intending constitutes an independent kind of behavior segment. It is true, of course, that sometime determination is only a factor in a more complex behavior situation, in which case the result intended is emphasized rather than the act of intending.

Purposive Behavior

The study of intentional action leads directly to the topic of purpose. Laymen do not distinguish between intention and purpose. The popular expression, "he did that on purpose," really refers to intentional action. Historically, too, the mentalistic psychologist regarded purpose as a mental state akin to that which he called intention. When we study specific interactions, however, purposive conduct is found to be quite different from intentional behavior.

In detail, purpose consists of a complex action which requires smaller unit actions to complete it. Tolman[2] describes purposive action very well when he says that any activity which has in it the characteristic of "persistence until" or "in order to" may be regarded as purposive behavior.

The fundamental mechanism in purposive conduct is the prolonged operation of a stimulus upon the individual. I read the story of a millionaire who started life as a poor boy. I am fascinated by the power this person achieves, how much good he can do in the way of founding hospitals, libraries, and universities. The result is that I become stimulated to be a millionaire myself. As long as this stimulus lasts it dominates my activities and motivates my whole life. Accordingly I work hard at my job, save my money, and seek to invest it wisely, all to the end of becoming a rich man and a benefactor of my fellow beings.

Willing and Desiring

It has become almost traditional to confuse willing and desiring. A study of the two kinds of action, however, reveals so many differences between them that they must be regarded as quite distinct. The primary difference, of course, is that desiring does not center around a conflict.

[2] E. C. Tolman, Instinct and purpose, *Psych. Rev.,* 1920, 27, 217-233; and Behaviorism and purpose, *J. of Philos.,* 1925, 22, 36-41.

When I desire to possess an object which I see displayed in a shop window I am stimulated by that object to carry on certain other activities with respect to it than merely seeing it. This object as seen merely operates as a substitute stimulus for the same object as possessed. I implicitly exercise upon it various activities of ownership, such as wearing it, bestowing it upon someone, etc. The activity of desiring has reference to some sort of ideal situation which I am unable at the present time to bring about.

Certainly it is true that desiring is sometimes closely related to willing. I may be stimulated to do something which I do not desire to do—it may be a very disagreeable thing. Then a typical voluntary action conflict is aroused. We must notice, however, in such a situation the desiring action merely makes a place for willing, but it is not the same thing. To want or not to want something may precipitate voluntary action, but it is not itself voluntary conduct.

Let us take into account, too, that very complex sorts of desiring are inevitably factors in willing situations. Consider the case of the tender-minded maiden who cannot accept the suit of the importunate lover and yet wants to want to say, "yes." Wanting to want to do something is a complicated type of desiring circumstance which occurs only when a resolution of action must be brought about by an energetic decision.

Why are willing and desiring so frequently identified? Both when I desire something and when I am checked by a conflict of stimuli, I am apparently for a time held in suspense as far as effective performance is concerned. This is only a superficial view of the matter, however. The student must notice that in the case of desiring there is really no suspension of action with respect to the desiring behavior segment. The interaction is immediate and complete in itself. In the case of willing, on the other hand, there is a genuine temporary suspension of action before the actual adjustment can be effected.

That the desiring action is an immediate response and a complete feature of the behavior segment is indicated by the fact that in certain types of desiring situations, such as wishing, yearning, and longing, no further activity may ever occur to complete the person's adjustment. Perhaps in all cases in which desiring is followed by other action, as when I finally purchase the object I desired, we must regard the desiring activity as a different behavior

segment altogether and as an action contributing to or influencing the performance of an entirely new behavior segment.

There is another point. Desiring is undoubtedly often confused with voluntary action because what is desired is the performance of an act. This performance is desired precisely because it cannot for some reason be brought about. The soldier would like to strike the officer who mistreats him, but there is no question of doing so for the risk is obviously too great. It may seem that the striking is inhibited. Were this the case we would have a voluntary action situation based on the alternative of striking or not striking. But there is really no question of striking. Even so, the conclusion of the preceding paragraph would apply. Desiring would not be willing, but only a condition thereof. The reaction is rather one of wishing that the officer were struck. The soldier is not really stimulated to strike, but only to wish that he might strike his aggressor. Though an action is desired the behavior segment is like that of desiring to possess something.

Willing, a Particular Type of Interaction

Our study of willing forces us to conclude that voluntary behavior is a special kind of interaction, one which involves particular kinds of conditions and especially the prominent operation of the person's tastes, ideals, and knowledge equipment. These personality traits are called upon to resolve a conflict between competing behavior alternatives. This explains why it is especially the individual's knowledge and ideal traits which are so outstanding in voluntary conduct.

A corollary follows, as we have already suggested. It is typical of voluntary action that it occurs in cultural situations. The problems of propriety and desirability of action, and the acquisition of tastes, obligations, and sense of responsibility develop primarily under cultural behavior auspices—that is, in the psychological groups of which we are members.

Experimental Studies of Voluntary Action

How willing behavior is experimented upon is well illustrated by the work of Ach (German psychologist), and Michotte, of the University of Louvain. Because experimental situations must be controlled and accurately described, these investigators naturally had to choose comparatively simple activities.

STRENGTH OF WILL.—Ach utilized a combination of the nonsense syllables of Ebbinghaus, and the reaction time experiment. Starting with the principle that when two nonsense syllables are associated together the presentation of one serves immediately to bring forth the other, he required his subjects to associate series of nonsense syllables. This he called an associative tendency which was all the stronger the more the two syllables were repeated. Next he introduced a variation in the ordinary situation by requiring his subject to respond not with the associated syllable but with one that would rhyme with the former, or one with the letters reversed. The acceptance of the instruction to rhyme or to reverse letters was presumed to constitute a determining tendency which would interfere with the associative connection. The measure of this interference, determined by the number of repetitions of the original association, Ach called an *Associative Equivalent.* Will-power was to be measured by these *Associative Equivalents,* and by the time-difference between associates which were or were not interfered with.

The results showed that the mistakes made in not abiding by the instructions to rhyme or reverse letters could be corrected by a more definite or stronger resolution. Such connections could be made no matter how many repetitions of the associated syllables were made. The time of reaction, however, increased in such cases. This would indicate perhaps that there were really no competing stimuli, and hence probably no measure of willing.

More recently the suggestion has been made that strength of will can be measured by recording the number of breathings that a person can perform by effort. The opposing stimuli here would be the ordinary habitual one which generally operates and the instruction stimulus to breathe more deeply. According to Tashjean[3] the number of breathings in spite of habit is an index of the intensity of the person's determination.

CHOICE.—Another form of investigation was that of Michotte. He presented cards upon which series of two integers were offered thus, 8|2, 5|4, and the subjects were asked to move a telegraph key as soon as they had decided either to add, subtract, divide, or multiply. The time taken provides a measure of the relative strength of the alternatives involved.

[3] Tashjean, A new method for the measurement of will-power: a preliminary report, *Psych. Rev.,* 1932, 39, 86-87.

Barrett performed a variation of this type of experiment. He arranged pairs of pleasant and unpleasant liquids which were designated by nonsense syllables and one of which the subjects were required to choose and drink. The time required to make the choice was measured. The object was to see what factor determined the choice. This investigator found that the choice is really determined when the liquids are arranged in series and labeled, and that during the experiment there is no real choice made. Barrett's experiment shows that only when there is a genuine competition between stimuli is there voluntary action.

All experimental findings obviously depend upon the problem which the investigator sets himself, the technique and apparatus he uses, as well as upon his method of work. As it happened, the early experimenters upon voluntary action were mentalists who conceived of will power as some sort of psychic force. It is interesting to note therefore that some writers have criticized Ach's experiments because the results obtained could be explained on the basis of attention rather than on the operation of a psychic will factor. Ach, however, himself agrees with those who believe in a mental process, and asserts that true will is a form of resolution represented by the expression "I really will." Barrett's work too has been criticized to the effect that arranging the stimuli in series automatized the action and masked the psychic effect. The organismic psychologist, however, asks whether the whole voluntary action situation cannot best be described in terms of competitive stimulus-response interactions.

CHAPTER XXI

IMAGINATION INTERACTIONS

Adjustmental and Creative Responses

When I react to a stone in my path, either by walking around it, jumping over it, or kicking it out of the way, my response may be properly described as an adjustmental one. I definitely adapt or adjust myself to that stimulus object. But when during my cross country walk I come to a stream and find it so flooded that I cannot leap over it, a simple adjustmental act is not sufficient. Since I cannot adapt myself to things as they are I must contrive some means of getting to the other side. I must alter or transform the objects or conditions that stimulate me. This I accomplish by the manipulative process of throwing a log across.

All such responses in which I modify or reconstruct the things with which I interact are imaginative. There is in addition one more essential factor; my action must be original. I bridge the stream by doing something which, as easy as it may be, is for me a novel bit of behavior. This means that the spontaneity of the individual is emphasized. My imaginative action may result in a definite construction, a behavior product, such as the contrived bridge in our example, or it may be wholly implicit as when I contrive a new solution for a mathematical problem.

Before proceeding further, let us be sure we understand the difference between creative and adjustment interactions. All psychological interactions are from the psychological standpoint adjustments. But there is an additional criterion of a primarily social character. In other words, the spontaneous and constructive character of imaginative behavior warrants its separation from ordinary psychological adjustments and its description as creative.

Imagination in the Service of Adjustments

Although the imaginative and adjustmental types of interaction are different, they frequently operate in the same behavior situation.

Many adjustments cannot be made without performing some kind of creative conduct. Indeed, we have already seen in our stream illustration that constructive behavior is necessary to carry out the ordinary adjustmental action of getting across.

Social intercourse provides numerous occasions for performing imagination reactions. The busy young man must invent numerous alibis to explain the apparent neglect of his fiancée.

When we cannot actually achieve some goal at which we aim we are able to accomplish it by imagining we have done so. Dreaming, when it is the fulfillment of some desire or wish, serves to bring about some adjustment, though in this case it is in a substitute form. An imaginary situation is constructed to replace an actual condition which cannot be changed.

Among the most effective adjustments brought about by means of imagination is play activity. Whether we think of play as the expenditure of superfluous energy (Schiller, Spencer), a relaxing activity (Lazarus), or as a preparation for future behavior (Groos), in every case it is replete with imaginative conduct. Observe that while playing, the individual is exuberant and highly active. In consequence a great deal of his behavior is constructive and creative.

It has always been agreed that the artistic side of human life involves adjustments to things requiring considerable imaginative behavior. The work of art may be regarded as the execution of a conception which the artist creates for certain purposes on the basis of his artistic training and development. Important criteria for evaluating works of art are the amount of originality in the development of the underlying conception and the amount of originality in the execution—that is, the actual handling of the art materials.

Nor can scientific and intellectual adjustments proceed very far without elaborate imaginative performances. The creation of a hypothesis we have seen is a distinctly imaginative procedure. Furthermore, scientific work may be summed up as primarily problem-solving activity, and as we know, to solve problems one must emphasize one's greatest ingenuity. Altogether this amounts to performing a complex set of creative activities.

Even the pathological phases of human life call for the performance of imaginative responses. The person described as a worrier or an anxious individual is so unfortunate as to create for himself all kinds of situations which interfere with his well being.

The hapless woman suffering from an anxiety neurosis daily sees her child run down by an automobile on his way to school and horribly mangled.

Combinative and Generative Imagination

Our exposition indicates that imagination occupies a larger place in our behavior life than is usually supposed. Accustomed as we are to limit imaginative action to mechanical invention and artistic creation, we fail to see that the child's arrangement of his blocks to form a new pattern is no less imaginative. There is really no difference in the behavior principle of these so widely differing instances of creative interaction.

Imaginative interactions, however, can be sorted into types. The criterion for this division is the amount of manipulation involved. The most manipulative and at the same time the crudest of all forms of imagination is the child's playing with blocks. This may be called combinative as over against generative imagination. The transformation is very simple and the best evidence that this overt and effective activity is creative is offered by the simple product which results from the interaction.

In the constant creation of puns and epigrams, as practiced by such masters of linguistic wit as Wilde and Whistler, there is no handling of objects, but only the rearrangement of speech materials. This is a unique type of imagination. The entire action involves less tangible materials and cannot therefore be manipulative in the same way as handling blocks. When verbal creations are transcribed, definite imaginative products are made available in the form of written or printed material. This type of creative behavior may be regarded as midway between combinative and generative imagination.

Probably the best example of purely generative imagination is the scientist's creation of a new conception or hypothesis concerning some natural phenomenon, as in the case of the modern physicist who creates a space-time continuum to take the place of discrete space and discrete time. Here there is no overt manipulative activity performed at all. The activity is completely implicit, although in many other forms of scientific creation implicit behavior is intimately associated with overt responses. This is the case when the mathematician is required to perform some calculations.

Dreams are almost entirely dissociated from manipulative interactions, and therefore constitute the freest form of creative behavior. Since the dreaming person is farthest removed from contact with things his imagination allows for the most bizarre creative activities.

Generative Imagination and the Unreal

Generative imagination accounts for the common expression that such and such is imaginary and not real. The traditional idea that imagination deals with unrealities of some sort is founded upon the fact that the products of such action need not have tangible existence like other objects. We can imagine objects which could never have any existence, such as unicorns, mermaids, and griffons. Likewise, the beauty which the ugly duckling imagines to be hers may have no manner of actual existence.

Such observations do not in the least overshadow the fact that imagination behavior operates in many of our most concrete activities. When we create new situations and objects to meet the exigencies of our daily living we are occupied with phenomena than which nothing can be more real.

Imagination Differs in Originality

Although all imaginative behavior is creative, it varies in degree of originality. We have already seen that the child's manipulation of his blocks may possess very little novelty.[1] As an example of a slightly more creative effort consider the following pair of simultaneous equations:

$$\begin{aligned} 3x + 2y &= 5 \\ 4x + 3y &= 4 \end{aligned}$$

While comparatively little ingenuity is required to solve these equations, still the process of multiplying the members of the first equation by 3 and of the second by 2 does after all constitute a novel manipulation of the objects.

The invention of a harvester, a cotton gin, or an adding machine, the conception of a new symphony or a scientific idea provide the opportunity for the opposite extreme of novelty and originality. This is true despite the fact that the history of practically every

[1] That is to say, from the observer's standpoint, not the child's.

major invention reveals a record of evolution, as well as rival claims to priority.

Because of the great variation between different types of imaginative conduct it is sometimes thought that such activities are different in kind. The truth is, on the contrary, that they merely constitute more and less intricate and involved responses of the same type. There is hardly any question but that these extremes are joined by interactions which completely fill the gap between them.

It is one of the paradoxes of imaginative behavior that the social importance of the product cannot be employed as a criterion for evaluating the originality of the imaginative interaction. The results of the most complicated and original creative behavior may have no theoretical importance or practical application while the simplest rearrangement of an old tool may yield a tremendous harvest of useful applications.

Inventive and Creative Imagination

All imaginative behavior is creative. This statement holds for the mechanical invention of the industrial engineer as well as the creation of the most original artist. But according to the degree of spontaneity the person displays in his behavior, and the transformation of the materials with which he works, we distinguish between the inventive and creative types.

Inventive Imagination.—An interesting anecdote is related concerning how the young Edison foiled the ingenuity of a strict local manager under whom he occupied a post as night telegraph operator. To make sure that his operators did not fall asleep the manager required them to report the word "six" every half hour. Edison did not like the idea so he promptly set to work to arrange a clockwork apparatus that would transmit the word at the proper intervals.[2] A similar though apocryphal story is told about Humphrey Potter, the alleged inventor of the steam-engine safety-valve.

Though it is not true that Potter contrived a valve gear as a result of being too lazy to turn cocks by hand to release an excess of steam, both anecdotes illustrate how creative activity may be definitely conditioned by a need for a more satisfactory working situation. Invention then may be regarded as fitting into some sort of adjustmental circumstance. The nature of the product, too,

[2] Hawks, The Book of Electrical Wonders, Macveagh, 1931.

is affected by its adaptation to alleviate an uncomfortable or undesirable situation. The originality of the inventive activity is therefore necessarily limited by the conditions mentioned. The situation is quite different in creative imagination.

Creative Imagination.—When Debussy was a student he handed in a composition which was not in accord with the conventional rules. "Don't you understand the principles of harmony?" he was severely asked. "No, not your harmony," he answered, "but I understand what I have done." Time has justified Debussy's rebellion against the conventional rules of composition. Such innovations are made possible precisely because artistic creation is quite independent of practical behavior circumstances, and is thus farther removed from any adjustmental condition. Whatever limitations are set upon the imaginative capacity have to do more with the experiences and behavior equipment of the creating individual than with the needs of a particular situation. Because creative imagination can be extremely spontaneous it is often not understood or appreciated.

Mechanical Invention Illustrated

The process of mechanical invention is excellently illustrated in the development of the radio tube, otherwise called the thermionic valve. Our story of the valve begins in the early days of Edison's work on the incandescent lamp. During the development of the lamp Edison noticed that when it was used for some time a deposit formed on the inside of the globe. This is now called the "Edison effect." He thereupon sealed a plate inside of the globe and insulated it from the filament. Next he noticed that when this plate was connected with the positive terminal of a battery, a galvanometer connected in the circuit indicated that a current was passing along the wire. This did not happen when the plate was connected with the negative terminal. Apparently the current jumped across the gap from the filament to the plate. This phenomenon observed in 1884 constituted a discovery containing the secret of wireless telegraphy and telephony as well as television. Though Edison was an inventive genius if there ever was one, he saw no use for this tube. The thing simply did not fit into the technological circumstances of the time.

The next step was carried out by Fleming, who improved the plate by making it cylindrical instead of rectangular as Edison had

done, and bringing it nearer the filament. Fleming's valve could then be put to work to detect wireless signals.

Some time after Fleming's improvements were made the valve was greatly developed by DeForest, who put a grid between the filament and the plate. The electrons passing through the grid to the plate make an impulse which is converted into sound waves by a telephone ear piece. DeForest's improvement made it possible to do more than detect waves. They could now be magnified or amplified. Thus the broadcasting and receiving of wireless became a practical technology.

The latest stage of development involves a new cultural situation with the participation of many workers and the employment of large laboratories and industrial resources. Thermionic tubes are developed to transmit power and the promise is held forth that not only will they be used for sound and sight transmission, but also for broadcasting electrical energy for power.

Imagination and Imagery

Psychologists no less than laymen confuse imagination with the imagal form of implicit behavior. True it is, of course, that some imagination responses consist entirely in performing image reactions, but it is a mistake to think of all imagination as exclusively imagal. As our examples indicate, the creative activity of the individual may be performed by means of overt and effective action.

Responses are Primary in Imagination

If it is ever allowable to speak of the primacy of one member of the inevitably mutual stimulus-response couple of a behavior segment we may do so in the case of the imagination response. For in quite a unique sense the stimulus object merely suggests an action which for its character depends almost entirely upon the make-up of the reacting individual. When a landscape stimulates an artist to paint it, even when his work is most imitative, we can only look upon the landscape stimulus as suggesting a response. Here it is true that the character of the stimulus is important, because if it were not beautiful enough to appeal to the artist, he would not paint it. Still the artist does not manipulate the landscape, even when he does reproduce it on canvas.

Again, the manner in which the inspired artist manipulates his paint and canvas is not dictated by anything but his artistic conceptions, skills, and techniques.

It is not surprising, then, that imagination responses are quite independent of their stimulating objects. The hungry man may be stimulated by his condition to imagine a situation in which he not only satisfies his hunger, but participates in a wonderful banquet. Naturally the best examples of the independence of the imaginative reaction of the stimulus is found in the purely implicit forms. When objects are merely substitute stimuli it is possible for the reaction to be considerably more prominent than the stimulus object.

Behavior Configurations in Imagination

Precisely how do we act imaginatively? Of the manipulative activities we have already spoken. Also we have suggested that imagination is to a great extent implicit. In addition to these there are still other behavior configurations which operate in imagination interactions.

Some of these are exemplified when the novelist develops a plot and creates his characters. Authors find the people they create in a crude form in their actual experiences. Was not the Micawber that Dickens created an idealization of his own father? It is said, too, that an "Angelica," whom his father knew when he was eighteen, was sentimentally exaggerated to produce the Dora of *David Copperfield* and enlarged into the comical personality of Flora in *Little Dorrit.* Students of English literature have recently satisfied themselves that they could identify the individuals that Chaucer drew upon as prototypes of his personalities in the *Canterbury Tales.* The situations and characters which the novelist puts into his book are only analogous to those he has met with in actual life. By means of his imagination he abstracts certain characteristics from observed things, which he then modifies either by exaggeration or simplification.

Metaphors, those vitalizing enzymes of language, are typical of the analogizing factor in imagination. Whoever first said he was "profoundly affected" or was "wrestling with a problem" created word objects by the process mentioned.

The Verbal Form of Imagination

Try to imagine the fourth dimension. It is inevitable that you will construct it primarily in a verbal medium. If the fourth dimen-

sion appeals to you as spatial you will probably not be able to imagine it as you do some feature of the other three space dimensions. But even if you think of the fourth dimension as not spatial at all but as time, then the same thing is true.

Again, imagine the age of the earth and the stars. Let us accept as the age of the latter a period of 5 to 10 trillion (5 to 10,000,000,000,000) years and for the earth one five-thousandth of this time. Since each of us must separately create our own conception of such time periods our reaction to them must be primarily verbal. We can repeat the phrase 5 to 10 trillion years, but our imagination stops there. The physical scientist helps himself by a new verbal instrument. He speaks of ten to the thirteenth power (10^{13}), a primarily linguistic reaction.

Astronomical distances likewise can only be reacted to verbally. When the astronomer tells us that there are thirty million island galaxies uniformly distributed through the space made available by the present day telescope, that this space reaches out to a distance of 300 million times the six trillion miles that light will travel in a year, that the candle power of the sun is 3×10^{27} or that 50,000,000 years are required for light to reach the earth from the nebula in Coma Berenices, the creative behavior we must perform can be accomplished only in verbal terms, or at least by calculative symbols.

Imagination Depends upon Personality Equipment

It is just as true of imagination as of everything else that there is nothing absolutely new under the sun. The psychological principle here is that inventive and creative behavior reflects the reactional biography of the individual. However unique or original a person may be he cannot transcend his personality equipment, which is, of course, derived from his contacts with objects. The way he writes a poem or builds a bridge depends upon his knowledge, his courage, and so on. Space forbids doing more than enumerating these various participating traits.

Knowledge.—Michelangelo's fame as a painter rests upon his masterful depiction of Biblical scenes on the ceiling and walls of the Sistine chapel. How could he create his masterpiece without knowing his Bible? In addition he had to pass through an apprenticeship to learn the technique of his art. While not all artists are

great innovators, no artist can be original unless he has in his possession a basic knowledge of his art.

Similarly, unless one has had experience with machines it is absolutely impossible to be a mechanical inventor. From a questionnaire study of 710 mechanical inventors, Rossman[3] gleaned the information that 59.8% of them were engineers, 23.8% executives of manufacturing companies, and 5.4% mechanics, while only 2% were professional inventors. Merchants and farmers each contributed .7% of the total. The low percentage of mechanics bespeaks a lack of general knowledge aside from technical craftsmanship, though Rossman suggests that a mechanic who is a prolific inventor probably calls himself an engineer.

That artistic creation is based upon knowledge is not a view shared by all artists. A striking example is found in the superlative contempt of Balakireff, the leader of the "mighty band" of modern Russian composers (Borodin, Cui, Moussorgsky, Rimski-Korsakoff), for the conventional knowledge of harmony. There was no sense in studying composition, he held; it was only necessary to compose, to create, and to learn from one's own musical experience.[4] As it happened, most of the members of this coterie later repudiated this doctrine after discovering their own deficiencies. What Balakireff meant to avoid was merely the slavish imitation of conventional methods. This attitude coincides, of course, with the psychology of creative behavior. Generally speaking, if one wishes to avoid the conventions of musical harmony one can do so only by knowing what those conventions are.

It is undeniable, of course, that amateurs can often make suggestions which the experts in a certain field will overlook. For experts are notoriously bound by tradition and precedent. Was it because Schliemann was not an archeologist that his imagination could accomplish what the experts could not dream? This truth, however, does not minimize the importance of knowledge as a necessity of practical imagination, since Schliemann was led by his original idea to study the technique and possibilities of excavation. The knowledge in his case came later, that is all. This situation is possible because the amateur's advantage over the expert involves more the conceptual than the executive phase of imagination.

[3] The Psychology of the Inventor, Inventors Publishing Co., 1931.

[4] See Rimski-Korsakoff, My Musical Life, Knopf, 1925, and von Riesmann, Moussorgsky, Knopf, 1929.

INTELLIGENCE.—Originality certainly presupposes intelligence. Even some of the simpler forms of creative behavior require a certain amount of agility and effectiveness.

EXPRESSIVENESS.—The literary personality not only has a story to tell, but he is interested in telling it without repressions of any sort. Of many writers it is said that their most intimate experiences were for them primarily material for literary copy. To create is to be articulate; but even more, it is to be expressive.

There is another sense in which imagination is fed by expressiveness. Of two newspaper writers, it will be said of one that he is original and creative, and of the other that he has a mechanical and wooden style. The more original journalist writes as his mood dictates, without matching every word with some kind of conventional standard. This person respects the balance between imitation and creation.

ENTHUSIASM.—It has probably never happened that a person driven by sheer necessity has produced a great product of imagination. Creative action must not only be free and unhampered performance, but it must also be charged with the galvanism of enthusiasm and even frenzy. "Imagination gallops while reason moves a step at a time."

COURAGE.—The poet Heine has said that he who creates a new idea faces Golgotha. In an earlier section we have indicated some of the misunderstandings and hatreds engendered by originality. Whoever is too timid to assail the citadel of established canons, prevalent taste, and immemorial usage, can never be a highly imaginative personality.

PERSISTENCE.—Edison, while in search of a suitable material for an incandescent filament, tried 6,000 different substances and expended 100,000 dollars. While this is a specimen of the most exaggerated persistence, it is still typical of the requirements of imaginative behavior. Inventors have gone hungry and neglected their families while being driven on by the urge to create a new object or a new process.

Development and Training of Imagination

Imagination begins in childhood. It is the children of the human family who are the originating and creating personalities.

Why is this so? Apparently because they are not hampered by practical needs or the multiplicity of conventions which hedge their elders about.

Because children are much freer in their activities than are adults their behavior manifests the unlimited play of whatever capacities they happen to have. This is why children, like poets, frequently do not distinguish between what exists and what is only verbally constructed. That is why they are mistakenly called liars. They do not lie; they only tell about things and conditions which they have created.

To preserve the creativeness of the individual is therefore the first step in his training. If scrupulous care is exercised not to stultify the individual's action, he will always respond imaginatively. In no wise does this mean that there is an originating native capacity which can be blunted. On the contrary, the preservation of the person's primary creativeness means to maintain the freer human circumstances of children. It means not to prescribe too rigidly what they shall wear, say, believe, and hope.

For the rest, it is essential to provide conditions for improving the individual's creative capacities. This is done by allowing for the enlargement of the child's personality equipment along particular, desired lines. His knowledge, tastes, courage, and other components of imaginative action need to be enlarged. Imagination activities depend upon practice and demand scope. This is as true of adults as of children. The more buildings an architect designs the greater possibilities he has for making the structural variations which constitute original work. Only in this way can his creative capacity be augmented.

Imagination and Genius

Of all psychological phenomena none can compete with genius in the interest and awe which it inspires. Now wherever you find interest and awe combined, there you have mystery. We shall not attempt to dispel the obscurity that surrounds genius. However, our understanding of it may be furthered if we point out that genius is not all psychological. Genius implies social acceptance and disapproval as well as psychological performance. Furthermore, genius as a psychological fact is not entirely a matter of imagination, though undoubtedly creative activity is an important ingredient.

The genius possesses an intense and efficient imagination. An

inventive genius frequently and intensively creates and recreates objects, as for example, machines in industry. The constructive genius may be a builder of new kinds of business systems, while the executive genius shows exceptional facility in the organization of military campaigns. And, finally, the artistic genius likewise displays profound originality in the development of artistic concepts and products.

While as we have just seen all imagination requires freedom, the more subtle and intense imagination of genius cannot exist without it. The genius must be free from restraint whether it be conventionalities of technology in invention, the rules of composition in music, or academic canons in painting. The lives of great artists testify to the general freedom of individuality which is reflected in the differences which mark them off from other people. Genius then may be regarded as an extreme form of individual difference. It is in this connection that the likeness is often pointed out between genius and insanity, poetically referred to as degeneration.

The freedom of genius is often coupled with universality of accomplishment. Not only was Goethe a supreme artist in literature, but he also displayed marked originality in various fields of science. Goethe very definitely anticipated the theory of evolution through his biological observations. Witness his conclusion that the flower evolved from the leaf. Also, as is well known, he was not an inconsiderable student in the fields of anatomy, geology, and color theory.

Aristotle is probably most widely known as a supreme master in many fields of knowledge and reflection. Leonardo, the painter, was also engineer, architect, and poet, while Descartes, the philosopher, was mathematician, physiologist, and physicist.

The channels of genius, however, sometimes cut deep rather than wide. Wagner and Beethoven are examples. They are great creators in the world of beautiful tone, but are not remarkable for achievement in other fields. Especially Beethoven was notably lacking in knowledge and imagination beyond the great realm where he ruled supreme.

Inspiration in Creative Behavior

Poincaré, the great French mathematician, describes in a very vivid manner the flash of inspiration which he experienced during some of his mathematical creations. "For fifteen days I strove to

prove that there could not be any functions like those I have since called Fuchsian functions. I was then very ignorant; every day I seated myself at my work table, stayed an hour or two, tried a great number of combinations and reached no results. One evening, contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning, I had established the existence of a class of Fuchsian functions, those which come from the hypergeometric series; I had only to write out the results which took but a few hours."

Artists of all sorts describe the same kind of experience. Painters and musicians speak of conceptions and ideas that come to them suddenly, they know not whence. They go further and say that ideas seem to have an existence of their own and force themselves upon the artist. Beethoven's biographers have reported that he frequently received sudden inspirations under the most diverse circumstances. Sometimes musical ideas would come to him while he was in the midst of a social gathering, or when he was out for a stroll in his favorite haunts. At such times he would stop and take in the melody or theme that came to him and either record it implicitly or put it down at once upon a scrap of paper conveniently carried for the purpose. It is a common practice of many creative personalities to keep in their pockets or near their bedside the means of capturing such treasured windfalls of inspiration.

This flash of inspiration which has always appeared as a mysterious happening is really the same thing as the "hunch" which everyone recognizes as a familiar occurrence in everyday life. Inspirations are really not as mysterious as they seem to be. Nor indeed are they so sudden or fleeting as ordinarily described. Creative behavior always consists of adjustments, of more or less protracted contacts with certain stimulus conditions. The "hunch" comes as a final result of brooding over a problem. The sudden idea is the culmination of a reactional momentum that operates after one has apparently ceased to respond to a thing. No one has failed to observe what happens when unsuccessfully trying to recall a telephone number, or name. Stop trying, and the name or number rushes in upon you. In musical or other artistic inspiration, however, there is a much greater detachment from surrounding conditions than is the case with the "hunches" of mechanical occupation or inventions.

According to Ribot, the French psychologist, there are two general mechanisms of creative imagination, from the standpoint of how inspiration is related to the rest of the creative process. The first mechanism involves some definite contact with a stimulus. The composer undertakes an opera or the mathematician must solve some problem. A period of incubation sets in, while the person broods over the work at hand. Next the solution comes in a flash. It is this way that Sir William Rowan Hamilton describes his solution of the problem of quaternions. The method suddenly burst upon him one day. "In that moment I had the result of fifteen years' labor." The last step is merely the verification of the results.

The second type of mechanism seems to begin with the inspiration. But it is clear that this has been preceded by an incubation period not definitely known to the person. This is the ordinary circumstance with painters and musicians. Such persons are continuously stimulated to productive effort. It is only when a certain conception becomes singled out that the artist believes he has been actively at work. After this period of inspiration he must develop and perfect his creative product.

Reputed Passivity of Imaginative Behavior

The biographies of artists, and especially writers, frequently mention what may be called the phenomenon of passivity. Many authors report that in their most creative periods it seems as though some one else were doing the work for them. This passive work is popularly regarded as the work of the unconscious. Thus de Musset says, "It is not work, it is listening; it is as if some unknown person were speaking in your ear." Stevenson expressed the same fact when he asserted that it was the little brownies who wrote his books. All he had to do was to sit by and passively record the words. Harris uses the following expression. "You know all of us have two entities, or personalities. That is the reason you see and hear persons 'talking to themselves.' They are talking to the 'other fellow.' I have often asked my 'other fellow' where he gets all his information, and how he can remember, in the nick of time, things that I have forgotten long ago; but he never satisfies my curiosity. He is simply a spectator of my folly until I seize a pen, and then he comes forward and takes charge. . . . When night comes I take up my pen, surrender unconditionally to my 'other

fellow,' and out comes the story, and if it is a good story I am as much surprised as the people who read it."

And finally Lamartine is quoted as saying, "It is not I who think, but my ideas who think for me."

To correct this facile generalization concerning the passivity of imaginative behavior consider the following observations. In the first place creative behavior is exceedingly individualistic. No one could have composed Beethoven's symphonies but Beethoven. Who will succeed in completing Shubert's Unfinished Symphony? No one but Pasteur could have achieved his scientific work.

Then, too, we must not overlook the fact that imaginative behavior is highly strenuous. While some creative activities are smooth and mild in execution we have already seen how strenuous and intense others are.

The ineptness of the passive or unconscious conception of creative behavior is manifest when we search out, as we sometimes can, the actual process of creation. Murry[5] has recently made a study of Keats's Ode on a Grecian Urn. He believes he has discovered the answer to the perplexing question of the last two lines:

> 'Beauty is truth, truth beauty,'—that is all
> Ye know on earth, and all ye need to know.

He found that they could be definitely traced to some readings that Keats had done some little time before composing this famous poem. This incident indicates how much like our other behavior creative conduct may be.

An exhaustive investigation of creative action with similar results is found in Lowes's study of Coleridge.[6]

Imagination and Feeling

No description of imagination is complete without indicating its close connection with feeling responses. All complicated imaginative reactions, and especially those that involve important products of creation, are heavily charged with affective materials. The person who is developing a new theory or composing a symphony is working under conditions of intense feeling. He is highly excited and alternately suffused with exultation and depression.

Probably the intensity of the feelings of the creative individual is responsible for the belief that creative effort is performed when

[5] The birth of a great poem, *The Hibbert Journal,* 1928-29, 27, 93-110.

[6] The Road to Xanadu, Houghton, Mifflin, 1927.

the individual is out of control of himself. Artists frequently describe their creative work as furious and strenuous performance, which they are driven to do by some force or power outside of themselves. We must notice that this type of experience contrasts markedly with that of passive creation.

CHAPTER XXII

ORGANISMS AS STRUCTURE-FUNCTION MECHANISMS

Psychology and Biology

The science of psychology intersects biology at a large number of points. The psychological organism is, of course, always an animal. Psychological and biological phenomena are therefore intimately related. For this reason it is very important that students of psychology should understand the organism from the standpoint of its biological organization and development. In the following four chapters are presented some of the salient features of biological science.

Divide et impera.—Scientists like politicians have discovered that in order to rule they must divide their subjects. Thus biological science, too, has been broken up into a series of specialties, each emphasizing a particular phase of living things. Accordingly biologists divide themselves according to whether they are primarily interested in (1) the structural organization of organisms, (2) the way these structures operate, (3) the way organisms reproduce, (4) the growth and development of organisms, (5) the adaptation of the organism to its environment, and (6) the evolution of the various species of animals.

Biology then comprises the following branches:

- I. Cytology (study of the structure and function of unit cells)
- II. Morphology (study of form and structure)
    - a. Anatomy (study of gross form, and organ structure)
    - b. Histology (study of microscopic structure of tissues)
- III. Physiology (study of the functioning of biological structure)

IV. Embryology (study of the ontogenetic or individual development of organisms)
V. Genetics (study of heredity)
VI. Ecology (study of the interrelation of the organism and its environment)
VII. Evolution (study of the phylogenetic or species development of organisms)
VIII. Pathology (study of the functional and structural disturbances of organisms)

Despite the fact that some scientists believe that even plants perform psychological reactions, in this brief summary we shall confine ourselves to animal biology and especially the biology of the human animal.

The Cell

In 1839 the German zoologist Schwann (1810-1881) published a work on the similarity of structure and growth in plants and animals, in which he wrote, "The elementary parts of all tissues are formed of cells in an analogous though very diversified manner." In the previous year the German botanist Schleiden (1804-1881) published a volume on plant growth in which he enunciated the same conception. Biologists date the establishment of the cell theory from the work of these scientists, although Hooke (1635-1703), an English microscopist, had observed in 1665 that cork tissue under the lens was made up of little boxes or cells.

The eminent biologist Schultze (1825-1874) is given credit for establishing the conception that cells consist of a particular substance called protoplasm, which not only gives form to cells, but constitutes the real structural and functional unit of organisms.

Although cells are regarded as the simplest units of biological organisms, they are themselves very complicated organizations of protoplasmic material. Protoplasm is for the most part chemically analyzable into carbon, hydrogen, oxygen, and nitrogen. As the diagram indicates (Fig. 59) this cell material is specialized into a peripheral portion called the cytoplasm, and a central structure called the nucleus. Sometimes the whole cell is surrounded by a cell wall, but not always.

The cytoplasm consists of a meshwork of material containing (1) structures of threadlike or oval, granular appearance called

mitochondria, (2) vacuoles, (3) plastid bodies, and (4) passive bodies called metaplasm or paraplasm.

Within the nucleus, which is separated from the cytoplasm by the nuclear membrane, there are two types of material: the first, a clear fluid portion; the second a network of denser and more

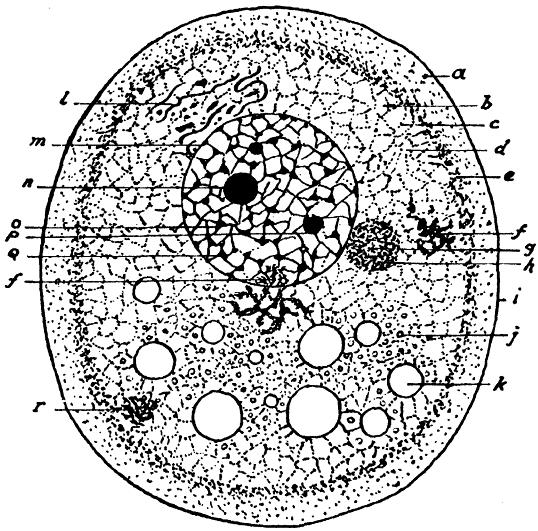


Fig. 59—Schematic representation of a cell. a, exoplasm; b, endoplasm; c, spongioplasm; d, hyaloplasm; e, microsomes; f, chromidia; g, centrosome (centriole); h, centrosphere, surrounded by astrosphere; i, cell membrane; j, deutoplasmic granule; k, fluid vacuole, or oil drop; l, mitochondria or plastosomes; m, nuclear membrane; n, nucleolus; o, linin; p, karyosome; q, chromatin (net knot); r, foreign inclusions, pigment, etc. (metaplasm). From Jordan, *A Textbook of Histology*, Appleton, publishers.

solid material. This network consists of the linin reticulum and a granular substance, called chromatin, which is regarded as the essential constituent of the nucleus. In addition the nuclei have within them bodies called nucleoli.

A third part of the animal cell, visible only at certain stages of development, is called the attraction-sphere. This contains one or two centrosomes, minute granules lying in the cytoplasm close to the nucleus, concerned with cell division and fertilization.

Chemical Composition of Cells.—Protoplasm is colloidal in character. This means that it is composed of aggregates of large molecules, varying from 0.0001 to 0.000001 millimeter in diameter,

suspended in water. Protoplasm is not, therefore a true chemical solution. It is more like glue or gelatin and consequently does not readily if at all diffuse through animal membranes. It is characteristic of protoplasm that under certain conditions it readily changes from a more to a less fluid state.

Various students have made chemical analyses of cells or protoplasmic structure. Here are two specimen results:

I.[1] a. Water (70-90%)

- b. Inorganic Salts (about 1%)
  - sulphates, carbonates, chlorides, phosphates — of — sodium, potassium, magnesium, calcium, iron
- c. Organic Compounds
  - proteins
  - fats
  - carbohydrates
  - extractives
    - inosite, $C_6H_6(OH)_6$
    - urea, $CO(NH_2)_2$
    - creatinine, $C_4H_7N_3O$

II.[2] Water 82.6%

Dried matter 17.4%	Water—soluble, organic materials, chiefly in vacuoles	amino acids, purin bases asparagin, etc.	24.3%
		monosaccharids	14.2%
		albuminous bodies	2.2%
	Insoluble in water, chiefly the ground mass of protoplasm	nucleoproteids	32.3%
		free nucleic acids	2.5%
		globulin	0.5%
		lipoproteid	4.8%
		neutral fat	6.8%
		phytosterin	3.2%
		phosphatids	1.3%
		other organic matter	3.5%
		mineral matter	4.4%

Organisms Constitute Biological Units

During the early development of the cell theory biologists concluded that the cell was the biological unit. In other words, the organism was supposed to consist not only of an aggregate of cell

[1] From Wieman, General Zoology, McGraw-Hill, (2) 1927.

[2] After Lepeschkin from Sharp, Cytology, McGraw-Hill, (2), 1926.

units, but the character and activities of the organism were thought to depend upon those of the individual cells.

Certainly there are indications that such a view is justified. In the first place, a considerable portion of the biological world consists of a single cell. Animals such as the Ameba, Paramecium, etc., carry on all the intrinsic biological activities just like the multicellular organisms (metazoans). In the second place, every complex organism begins as a simple cell endowed with all the capacities requisite for differentiation and growth. And in the third place, there are many cells, such as the ameboid bodies, which appear to maintain an independent existence even in the complicated organism.

This conception has, however, been opposed from its very origin by other biologists who regarded the total organism as a unit, no matter whether it consists of one or a very large number of cells. Ever since the cell theory was first formulated biologists insisted that the total organism, whether animal or plant, is an indivisible unit and must not be regarded as made up of parts. They have argued for the unity of the organism-as-a-whole. Upon what basis?

To begin with, the existence of single-celled organisms with differentiated functions indicates that the separation of organic beings into units is not a fundamental principle. Again, it is impossible to look upon organisms as merely aggregates of unit cells; for cells are not equivalent objects. Each type of cell has its own distinct function in the biological economy of complex organisms. And the evidence indicates that these differentiable functions or cells are determined by their place in the organism as a whole. Among such evidences are the facts of regeneration and transplantation. When organisms like flat or round worms are cut, they regenerate the missing parts on the basis of the original plan of the organism. Biologists have shown also that when cells are transplanted from one anatomical region to another they develop not as they would if they had been left in their original place, but rather as do the parts of the organism in the transplanted region.

All of these considerations seem to favor the view that cells are not organisms or units fitted together to make a whole, but are differentiated parts of a single unit. This is the organismal or organismic conception of biology.

Those biologists who refuse to accept the organismal theory do so because they suppose that the theory implies a mysterious whole

irrespective of the parts. This is no necessary part of the theory at all. It merely substitutes for the conception of a topographical interrelation of fixed units the more dynamic notion of an organism as an interactional mechanism, whose organization and reactional properties are determined by its interactions with the surroundings. Now whether the biologist finds the cellular or organismal conception more acceptable from the standpoint of his particular researches, it is certain that the organismal view is of greater significance for the psychologist.

Numbers of Cells.—Not the least marvelous fact of biology is the great numerical variation in the cellular constituency of organisms. The range obviously has its lower boundary in the one-celled animal or plant. The upper boundary is not known, but it represents a tremendously large number, as in the human organism, for example. It is estimated that the human cerebral cortex contains about 9,280,000,000 neural cells (Herrick).[3] Walter[4] quotes Keen as estimating that in each of the 12 pints of blood in the body of a 144 pound man there are 10,240,000,000,000 red blood cells. According to a calculation made by the anatomist Donaldson[5] the body of a man weighing 155 pounds contains, 26,500,000,000,000 cells. This would appear to exclude the blood cells if Keen's estimate of their number is significant.

Characteristics of Organisms

Organization.—As the term organism implies, every living thing is definitely organized. We have already seen that even a single cell has a very specific relationship of parts. This organization is threefold. First, there is the general biological arrangement of parts (head, trunk, appendages, etc.) and functions (digestion, contraction, etc.) to constitute an organic individual. Secondly, there is the particular organization consisting of specific traits peculiar to some particular individual. A third and fundamental feature of biological arrangement is its relative constancy. So far as the general biological arrangement goes this may be distorted and interfered with within limits. Such are the various dyshygienic or patho-

[3] Introduction to Neurology, Saunders, 1931, p. 28.
[4] Biology of the Vertebrates, Macmillan, 1929, p. 132.
[5] Cowdry, in Human Biology and Racial Welfare, Hoeber, 1930, p. 187.

logical conditions (diseases) of an organism. But when this process proceeds too far the organism dies.

Species organization, including color, size, and shape, varies greatly from individual to individual, though there is a definite tendency toward a pattern—that is to say, the form of the species or group. The individual, too, changes; a person may be as much as an inch taller after a good night's sleep than after a day's work; he may be pale or flushed, heavier or lighter, but in spite of these variations the organization of the individual remains relatively constant.

METABOLISM.—Organisms are constantly being built up and broken down. Metabolism is a series of processes tending toward the continued existence and organization of the individual. The building-up process is called anabolism and the breaking down katabolism.

Anabolism is in general a process of storing up energy-supplying materials which are utilized as required. For example, the fatty materials of the diet are stored in fat cells, sugar and protein in the liver cells. Starchy foods are changed in the alimentary system first into glycogen or animal starch $(C_6H_{10}O_5)^n$ by the action of various enzymes. This glycogen is stored in the muscles and liver, and is the source of the organism's energy. It is this storage activity which is primarily the building-up process.

When the organism has work to do, as it always has, the storehouse of energy must be broken down and used. This is the katabolic process. The addition of water to glycogen results in the formation of glucose or grape sugar, one of the monosaccharids, $C_6H_{12}O_6$. From the storage places this glucose is carried by the blood to the muscles where it is used or burnt in the performance of work. In the muscles the glucose breaks down, with the formation of lactic acid $C_3H_6O_3$ and the production of energy for muscle contraction. The admission of oxygen into the chemical processes at this time adds the energy necessary for the muscle recovery process.

This carbohydrate explanation of the metabolic processes involved in muscular activity now faces a formidable rival. Physiologists are coming to believe that muscular action, instead of being a carbohydrate chemical reaction, involves phosphate and creatine.[6]

[6] See Hill, A. V., The revolution of muscle physiology, *Physiological Reviews,* 1932, 12, 56-67.

In muscular contraction phosphagen (creatine-phosphoric acid) in the absence of oxygen breaks down into creatine and phosphate. These substances are resynthesized in the presence of oxygen.

Growth.—In order to reach the goal of its species pattern, an organism must pass through various developmental stages. This is the maturation or growth process. Organisms grow by intussusception. This means that the animal takes into itself materials from the outside and transforms them chemically into a part of its own organization, as in the ingestion and digestion of food. Inorganic things grow by the contrasting process of accretion. The classic example is the organization of a crystal when emerging from a solution.

Two general series of conditions operate to influence the growth of an organism. There is first a great number of interactional circumstances that have gone to make up the species pattern and character of an individual (phylogenetic conditions), and secondly the circumstances surrounding the development of the particular individual (ontogenetic conditions).

Movement.—Change, which is a constant phenomenon in all nature, is more manifest in organic than in inorganic objects. In the former the redistribution of energy is rapid and continuous even when the object maintains its normal structural appearance. In inorganic things smaller energy changes result in more or less complete structure transformation. The explosion of a shell is an example in point. Internal changes having to do with metabolism and growth are paralleled by the gross movements of the whole organism throughout the range of its normal habitat.

Responsiveness.—In Chap. I we have already seen that organic things, by storing up energy within themselves, can expend more energy than is immediately expended upon them. Biologists refer to the simpler phases of this condition and activity as irritability, whereas in their more complex phases they amount to a definite responsiveness.

Reproduction.—Organic objects continue in existence through a process of cycles. Individuals for the most part die, but some cells constituting a part of the total individual develop into new individuals. Reproduction in the simpler animals constitutes the mere continuation of a single individual, whereas in more complicated animals parts of different individuals, males and females,

The Aggregation of Cells into Tissues

Although the organism is an indivisible unit, biologists find it scientifically expedient to regard it as made up of unit cells. These cells vary in all sorts of ways, in size, shape, and function. Repre-

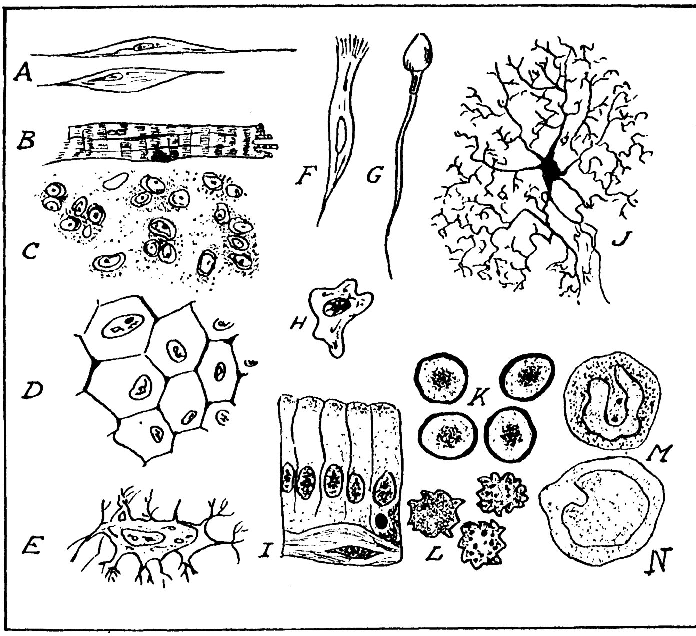


Fig. 60—Various forms of cells. A, smooth muscle; B, striated muscle; C, cartilage; D, squamous epithelium; E, bone; F, ciliated epithelium; G, spermatozoon; H, ameboid leucocyte; I, columnar epithelium; J, nerve cell; K, red blood corpuscles; L, crenated red corpuscles; M, polymorphonuclear leucocyte; N, large mononuclear leucocyte. I-N from Jordan; the remainder from Walter.

sentative cells of various sorts are indicated in Fig. 60. Cells of similar form and function are grouped together to constitute tissues.

FLUID TISSUES.—*A. Blood.* Blood is made up of four kinds of cells, floating in plasma which is about 80-90 percent water.

One type of blood substance, the erythrocyte or red corpuscle,[7] appears as a circular disc consisting of one third haemoglobin. The red corpuscles are concerned with respiration or oxygen transportation. The haemoglobin becomes charged with oxygen in the capillaries of the lungs and is then called oxyhaemoglobin. This oxygen content is carried to and released at points where it is required.

Leucocytes or white blood cells comprise four main types. Having nuclei they are true cells. Unlike the red corpuscles, which perform their life functions in the blood stream, the white cells function only outside the blood system. These cells by their ameboid movement pass through blood vessels (diapedesis). They get back into the blood stream by means of the lymphatic vessels and are then transported to various places. About one fourth of the total number consists of (1) *lymphocytes,* which are spherical, most of them being about the same in size as the red corpuscles. (2) The *granulocytes* or polymorphonuclear leucocytes are somewhat larger than the lymphocytes, and are generally divided into three types: (a) Neutrophilic leucocytes constitute the most numerous, show rapid ameboid movements, and feed actively upon bacteria and other small particles, thus functioning as the microphages of the organism. (b) The eosinophilic leucocytes are characterized by their affinity for eosin stain. Their function is not well made out. A third sparsely numbered form of granulocyte is (c) the basophilic leucocytes, the function of which is also in doubt. (3) The third form of white blood cells is the *monocytes* or mononuclear leucocytes. These are large cells numbering at most 10% of all leucocytes. These, like the neutrophilic leucocytes, are highly phagocytic. (4) The *megakaryocytes,* large non-phagocytic lyphocytes usually found only in the blood of red bone marrow, constitute the fourth type of leucocytic cell.

The third type of solid blood substance consists of the thrombocytes or blood platelets. These are not regarded as complete cells, but they serve the important function of assisting in the clotting of blood.

The fourth type of blood substance is called blood dust, which is a series of fine protein and fat particles. It also contains the remains of degenerated red corpuscles.

B. Lymph. This is also a fluid tissue like blood. There are no red corpuscles floating in this fluid, though there are lymphocytes and monocytes. Lymph, like blood, coagulates, though not so rapidly. This fluid originates in part from the tissue juices.

EPITHELIAL TISSUE.—To a considerable extent these tissues are composed of layers of cells constituting an outside surface such

[7] Because these structures lack nuclei biologists prefer the name plastid (erythroplastid) or corpuscle for these bodies.

as the epidermis of the skin, or interior lining (mucous membranes). But much epithelial tissue goes to make up receptor and secretory structures. Because epithelial cells contain very little intercellular material they are packed tightly together. In structure, they are squamous or pavement shaped, cubical, or columnar. The last frequently are ciliated. Some of these epithelial cells are indicated in Fig. 60. In general, all epithelial tissues are classified as (1) simple or non-stratified when they compose membranes one cell in thickness, and (2) complex or stratified when they consist of superimposed cell layers.

Various functions are performed by the epithelial tissues. In the form of skin tissue they are protective. When they go to make up the glands of the digestive tract, tear organs, and other glandular mechanisms they are secretory in function. As sweat glands of the skin they are temperature regulating, and when they constitute end organs or receptors they subserve the function of external excitation.

Connective Tissue.—Unlike the compact epithelial tissues the cells in connective tissue are diffuse. Between them is a matrix containing a large amount of intercellular material, especially fibers, although there is also fluid substance or tissue juice. The different kinds of connective tissue are determined by the specific organization of fibers, matrix, and cells. Although this organization suggests that the connective tissues are space-filling, it must be pointed out that they also comprise the place where the blood effects its food and waste exchanges with the tissue cells.

The connective tissue cells consist of five main types. (1) The most numerous are the fibroblasts which form the fibers. In form they are like plates, stars, or spindles. (2) The histiocytes or clasmatocytes, large, round cells, move by means of pseudopodia to seats of injury and consume dead cells. (3) Derived from lymphocytes are the plasma cells which have no definitely known function. (4) Mast cells are variously described by histologists, but their function is not specified. And finally, there are (5) lymphocytes and various leucocytes passing through these tissues from the blood and lymph.

Among the many forms of connective tissue we consider only three forms—namely, (1) the reticular, (2) the fibrillar, and (3) the adipose.

(1) The distinguishing feature of the reticular tissues is that the constituent fibers are very fine and grow together to form a network. Such networks support the parenchyma—that is, the specific tissues of the spleen, lymph nodes, and other soft organs. When there are many lymphocytic cells combined with these fibers, the tissues are called lymphoid or adenoid.

(2) The fibrillar form of connective tissue is the most abundant of all. There are three types. (a) The areolar consists of loose collagenous or white fibers arranged in bundles, and a few isolated yellow or elastic fibers. These tissues are said to fill in every place that is not otherwise provided for. They connect the skin with the underlying structures, surround the heart and great blood vessels, etc. (b) Dense fibrous connective tissue consists of great numbers of white fibers packed tightly together with a few yellow fibers in parallel bundles. They comprise the ligaments, tendons, valves of the heart, and other firm and rigid organs. (c) In dense elastic tissue the yellow or elastic fibers greatly predominate over the white fibers. This tissue is found in the walls of blood vessels, in the trachea and bronchii, and in the larynx.

(3) Adipose tissue is also a connective tissue. It consists for the most part of droplets of fat connected with loose fibrous or areolar material. In this type of tissue the cells are more prominent than the intercellular substance.

Supporting Tissue.—Although some of the connective tissues are supporting in function, they may all be sharply distinguished from the fundamental supporting tissue which consists predominantly of cartilage and bone.

A. Cartilage tissue, commonly known as gristle, stands between the simple supporting substance of the connective type and the rigid effective scaffolding of bone. This tissue is a dense, firm, and elastic substance unsupplied with blood or nerves. Histologists distinguish three distinct forms on the basis of the type of fiber and matrix substance present.

(1) Hyaline cartilage is the most abundant, and is characterized by the presence of very few fibers. In this tissue, therefore, the cells are very prominent. Hyaline cartilage develops first in the organism, and is generally replaced by bone. In the adult organism,

however, it does constitute the cartilages of the nose, larynx, trachea, bronchial tubes, and the costal cartilages of the ribs.

(2) When the cartilage matrix is permeated with elastic, connective tissue fibers, it is called elastic cartilage. Such tissue is found in the ear structures (auditory tube and external ear), epiglottis, and some of the laryngeal structures.

(3) Fibrocartilage occurs in the articulatory structure of the lower jaw, the intervertebral discs, the clavicle, and the knee. In this tissue there are many white fibers as in the tendons, but there are also cartilage cells absent in tendons.

Cartilage tissue, except fibrocartilage, is encased in dense fibrous membranes called perichondrium.

B. Bone tissue consists essentially of cells surrounded by calcium and other inorganic salt substances. The rigidity and support of bone depend upon the solidity imparted to them by means of these salt compounds, which constitute about 15 percent of the total bone tissue. Walter quotes Heintz as giving the following chemical analysis:

Calcium carbonate	9.06%
Calcium phosphate	85.62%
Magnesium phosphate	1.75%
Calcium fluoride	3.57%

Bone tissue in general is of two types. Spongy or cancellous tissue is composed of a network of compartments in which the bone marrow is contained. Compact bone consists of the denser portions of calcareous substance.

Flat bones consist of plates of dense or compact bone tissue, between which are found sponge-like compartments. The ends of long bones, too, have this form of structure, but the shafts are mostly compact osseous tissue. Compact bone is made up mainly of lamellae or plates arranged in three ways. The first are the circumferential plates, surrounding the large marrow canal of a bone shaft like a series of concentric rings up to the outside surface just under the periosteum, which covers bone as the perichondrium covers cartilage. The second, called the concentric plates, occupy a similar position with respect, not to the whole shaft, but to the Haversian canals, which permeate the shaft lengthwise. These

Haversian canals (Fig.61) are the passage ways for the capillaries, lymphatics, and nerves, and are responsible for the porous character of bone tissue. The third or interstitial plates fill up the irregular spaces between the Haversian systems.

The cells themselves are located in lacunae or little lakes which are found between the different plates. These intercommunicate by means of little canals called canaliculi, which are microscopic perforations in the lamellae. It is these interconnecting canal systems and the connected lacunae which, in addition to the Haversian canals, contribute to the porosity of the bone.

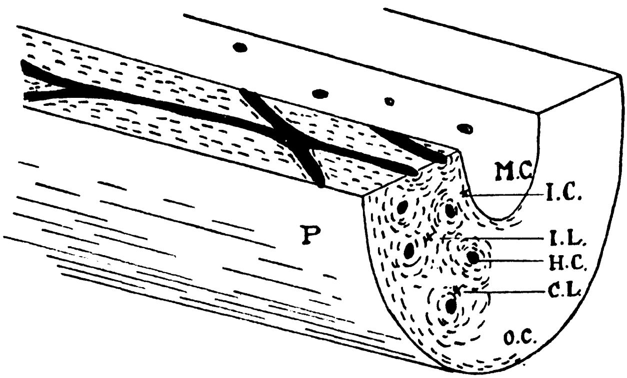


Fig. 61—Diagram of bone structure. Black portion represents Haversian canals and lacunae, white represents lamellae. M. C., marrow cavity; I. C., inner circumferential lamellae; I. L., interstitial lamellae between the Haversian system; H. C., Haversian canal; C. L., concentric lamellae around canal; P., periosteum, surrounding the whole bone; O. C., outer circumferential lamellae. From Walter, *Biology of the Vertebrates,* with the permission of The Macmillan Co., publishers.

Teeth are special forms of bones. The exposed or enamel portions of teeth are the hardest of all tissues, hence their protective function. The composition of tooth enamel is about 90% calcium phosphate and about 4% calcium carbonate. Beneath the enamel is the dentine or ivory, a tissue honeycombed with tiny parallel canals which surround the pulp cavity containing the nerve and blood supply. A third kind of bony tooth tissue, called cement, covers the roots, and aids in anchoring the teeth in the bony sockets of the jaw.

Muscle Tissue.—According to the physiologist's schedule of the division of labor it is the muscle tissues which, by their contrac-

tions or pulls, perform the organism's work or produce its movements. There are three general types of muscle tissue.

(1) The *striped* or *skeletal* muscles are commonly miscalled voluntary on the assumption that they are under the direct control of the "will." These tissues constitute the flesh of the organism, and make up about 50% of its total weight. The cells of this tissue consist of long fibers (Fig. 60B) 36 millimeters or less in length and from 0.1 to 0.01 mm. in width. These fibers are organized into fasciculi or bundles. The fibers themselves are also structurally analyzable into tiny fibrils called myofibrils, and it is these that are believed to be the actual functional elements of the musculature. Striated muscle fibers, because of their length, contain many nuclei. The fibrils lie in sarcoplasm, which is a semi-fluid cytoplasmic substance, and each fiber is encased in a membrane called the sarcolemma.

As the name indicates, these muscle fibers are alternately crossed by light (isotropic) and dark (anisotropic) bands. These cross striations probably have a great deal to do with the twitching or contractile action of skeletal muscles, but just how or why physiologists do not pretend to know.

(2) *Smooth* muscle tissue, so called because of the absence of striations, is found in many organs. (See Fig. 60A.) It composes a part of the alimentary tract, respiratory system, gland ducts, the skin (where it serves to raise the hair), the various blood structures, and the intrinsic eye muscles (ciliary, pupillary sphincter).

The cells comprising the smooth muscle fibers are exceedingly minute, ranging from 20 to 600 μ[8] in length, and from 2 to 8 μ in diameter. Accordingly, such cells contain only one nucleus.

(3) Despite its resemblance to striated muscle, histologists regard the *cardiac* muscle tissue as a distinct form. Heart tissue is striated, but the striations are less marked than in skeletal muscle. The fibers anastomose or grow together to make continuous tissue, and partly obliterate the individual fibers. The function of cardiac or heart muscle (also found in the roots of the aorta, pulmonary arteries, and veins) is to provide a continuously operating blood-pumping apparatus.

NEURAL TISSUE.—Just as the glandular tissue is apportioned its secretory activities by the physiologist, and the muscular tissue its

[8] Micron (plural, microns or micra) equals one-thousandth of a millimeter (m.m.).

contractile or movement functions, so the neural tissues are assigned the work of integrating and coordinating the behavior of the total organism.

This integrative activity is performed by the brain, spinal cord, and nerves. These structures are all made up of neural cells called neurons, and their supporting tissues. In the central nervous system the supporting tissue consists of neuroglia, while in the periphery the same function is performed by areolar connective tissue.

Neurons (Fig. 62) consist essentially of a cell-body or perikaryan containing a nucleus and cytoplasm, with a short tree-like process at one end, called the dendron or dendrite, and an elongated branch or axon terminating in a smaller branching process, called the end-brush, at the other.

The above describes a bipolar neuron, but there are many other kinds. The cell body may give rise to numerous separate dendrons (multipolar cell), or there may be only one process coming off from it (unipolar cell). When the cell is unipolar the axon may branch off from the dendron, or there may be an axon without any dendron.

Because of the great variety of neuron shapes, the question arises how to determine when a process is a dendron or an axon. There is a functional and a structural answer. Structurally, it is declared that dendrons can be distinguished from axons because the former do and the latter do not contain Nissl bodies. From a functional standpoint a dendron is that structure which conducts toward the cell body, while the axon conducts the impulse away from it.

The nucleus of the cell body is characterized by a nucleolus containing chromatin, while the cytoplasm contains a flake-like chromophyllic substance called Nissl bodies, and a network of fibrillae which course through the entire cytoplasm of the cell (Fig. 62). Some neurologists believe that it is these neurofibrils which are the actual conductive elements of neural cells.

As the illustration shows, the axon or axis cylinder gives off collaterals at various points, which aid in the conductor function. This axis cylinder is usually covered with a sheath of myelin or fat-like substance, and is then said to be medullated. It is this sheath which gives the white appearance to neural tissue, so that it is divided into white and gray matter. In peripheral neural tissue (nerves) another sheath may encase the neural fiber, and when this

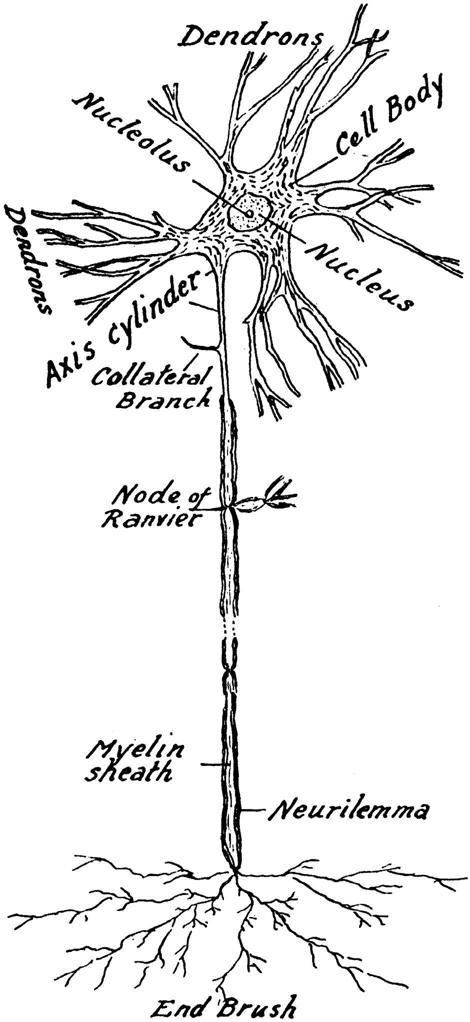


Fig. 62—Conventionalized diagram of a neuron.

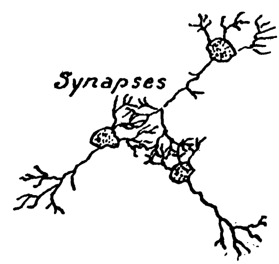


Fig. 63—Diagram of neural connections or synapses.

occurs the covering is variously called the neurilemma, the primitive sheath, or sheath of Schwann.

Just as it is characteristic of epithelial tissue to be arranged in cell rows or in layers, so the neurons are arranged in relays or chains. This organization fits in with the function of nerve cells,

which is to conduct impulses. The relay arrangement of neural cells provides a definite polarity, since the impulses always travel in one direction—that is, from the dendrons through the cell body and then through the axons.

An exceedingly important feature of neural organization is the place of juncture between neurons—namely, the synapse. It is the synaptic character (Fig. 63) of neural organization that makes possible the integration and coordination of the organism's activities, for it is by means of the connections between the great number of these cells (there are between 9 and 10 billions of them in the cortex of the brain alone) that every part of the organism can be interrelated with every other part.

It is one of the oddities of science that the neural tissues have been regarded as more especially concerned with psychological phenomena than any others. This fact has had peculiar consequences in the study of neural physiology. As recently as 1846 the great physiologist Johannes Müller (1801-1858) regarded nerve action as the operation of an imponderable or a psychical principle. It seemed obvious to him therefore that little or nothing could be known about the nature of the neural impulse. He asserted especially that we should never be able to determine the velocity of the nervous impulse, since the time required for the transmission of the psychic factor was infinitely small and unmeasurable.

This view, however, was not shared by his students. One of them, du Bois-Reymond (1818-1896) had experimented upon the electrical properties of tissues, and appeared to demonstrate that the nervous function has to do with an altered arrangement of the material particles of the tissue. About 1852 Helmholtz (1821-1894), working on the sciatic nerve of a frog, stimulated the tissue at a point near the muscle and at another point close to the spinal cord. The muscle action elicited from the far stimulation required longer to occur. From the differences in distance and time required he concluded that the velocity of the impulse in the motor nerve of a frog ranged from 28 to 30 meters per second, at average room temperature. In some human nerves the rate is believed to be as high as 120 meters per second.

Physiologists are not entirely certain as to the exact nature of neural impulses. They are, however, coming to be increasingly regarded as a condition of electro-chemical change which is propa-

gated along the surface of neural fibers. The neural function then is not only brought within the domain of natural science investigation, but it is certain that, aside from its specific property of integrating the organism's action, its activity is quite comparable with the operation of other tissues.

For example, physiologists have discovered that nerve fibers, like muscle fibers, pass through a period of inexcitability immediately after they have functioned. This inert interval is referred to as the refractory period. For a period of from 2 to 3 milliseconds after an impulse has been conducted over a nerve fiber, that fiber cannot be made to conduct another impulse, no matter how strongly it is stimulated. After this absolute refractory period there is a gradual return to normal excitability. The time between the end of the absolute refractory period and the return to normal is called the relative refractory period. In the frog this requires about 13 milliseconds. Between the relative refractory period and the normal or resting stage of the fiber it may show an abnormally high excitability up to 0.1 second after stimulation. The absolute refractory period may be much prolonged by subjecting the fiber to low temperatures and drugs.

The operation of the neural tissue shows evidences of metabolic changes exactly as every other type of tissue. When neural tissues conduct, they consume oxygen, eliminate carbon dioxide, and generate heat. Another fact which physiologists have elicited concerning the functioning of nervous tissues is that there is no qualitative difference between sensory and motor conduction. The rate of conduction, however, is now thought to be different in different fibers, even when both are afferent or efferent. Fibers with large myelin sheaths are regarded as having the greatest velocity and irritability.

Nerve fibers, just like muscle fibers, have been found to operate according to the "all or none" law. This means that when a wave of disturbance is induced in a fiber it is propagated at its maximum capacity, no matter what the intensity of the stimulus may be, as long as it is sufficient to excite the disturbance. In effect, neural action like all biological phenomena, depends primarily upon the character of the structure or cellular material, and upon its conditions. Thus the action of the nerve fiber can be modified by drugs and fatigue, but not by the intensity of the stimulus, although without a stimulus the fiber cannot, of course, operate at all.

CHAPTER XXIII

THE BRAIN AND OTHER ORGANS

The biologist regards the organism as a hierarchical organization of structures. As we have already seen, he begins with the idea that cells make up tissues. Organs may therefore be defined as patterns of tissues which perform particular functions on the basis of evolutionary development. Up to very recent years psychologists have been interested primarily in the brain and the sense organs or receptors. Then the glands took on considerable importance. But if it is true that the organism always operates as a unity it would appear improper to overlook the essentiality of any organ, since all organs participate in every action.

The Skin

In the human animal the skin is a very complicated organ. It is roughly divided into three layers (Fig. 64). On the external surface is the epidermis or cuticle, consisting of epithelial tissue which varies in thickness, depending upon the exposure and mechanical contacts to which it is subject. The epidermis itself is divided into various layers of cells, the chief of which are the stratum corneum, a sort of horny layer, and the Malpighian or inner layer of living cells. It is this layer, named after the great Italian anatomist Marcello Malpighi (1628-1694), which contains the pigmentation that gives a person his complexion type.

The second skin layer is variously called the corium, derma, or true skin. Interlaced with the connective tissues are smooth muscle cells, nerve tissue, blood vessels, various glands (sweat and sebaceous), and numerous end-organs such as the corpuscles of Meissner.

Between the corium and skeletal muscle tissue lies the subcutaneous layer of the skin organ. A distinctive feature of this layer is that in addition to being the matrix for many nerve endings

and other structures, such as the corpuscles of Pacini and Ruffini, it also houses a great deal of fat tissue.

As we should expect, so complicated an organ as the skin has many functions. We can only mention a few of them. (1) In the first place, as a containing organ it holds the parts of the organism in place and separates it as a structural unit from its environment. (2) The skin is decidedly a protective organ. It con-

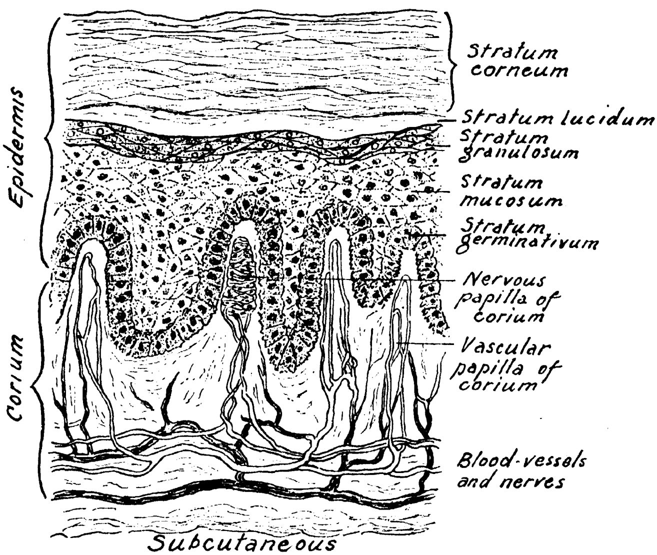


Fig. 64—Section of human skin showing the complex arrangement of cell layers. From *Cunningham's Anatomy,* Oxford Univ. Press.

stitutes a great defense against mechanical injuries and predatory organisms. Unless broken, the skin is to a great extent germ and bacteria proof. (3) In preventing the escape of an excessive amount of heat it functions as a heat regulator. (4) As an organ of excretion the skin is somewhat akin to the kidney. (5) And finally, the skin serves as a storehouse for fat, which means that it is a sort of granary for the rest of the organism.

Muscle Organs

Because of their extreme familiarity we take as our examples of muscle organs the tongue and the biceps.

The Biceps.—At one end this muscle is attached to the scapula or shoulder blade, and at the other to the radius and ulna—that is, to the long bones of the lower arm. Its primary function is the flexion of the elbow joint and arm, the rotation of the forearm, and the raising of the arm.

When lifting a weight held in the palm of the hand, the biceps works in conjunction with the brachialis anticus muscle which lies beneath the biceps. This action abstracted from the rest of the cooperatively performing organism yields some very interesting facts. According to Hill[1] these two muscles in a fairly muscular man weigh together about one half to three fourths of a pound, yet in a single contraction enough work is done to raise an equal weight 100 feet into the air.

But more exciting still is the fact that, as Hill points out, these muscles are working at a great mechanical disadvantage. Since the muscles are attached to the bone at one end, and the weight is at the other, they pull on a lever close to the fulcrum. This condition yields a mechanical disadvantage of 10 to 1 against the muscle. On the basis that a man can at least for a second or two hold with both hands a horizontal rod weighing two hundred pounds, the physiologist estimates that the capacity of the muscles is about 2,000 pounds or from 1,300 to 2,000 times their own weight.

The Tongue.—Although the anatomist calls the tongue a muscular organ it really is much more than that. So far as muscle tissue is concerned the tongue is made up of numerous fibers arranged in a variegated pattern. All these muscle fibers fall into two large divisions. The first, called the intrinsic muscles, consists of series of longitudinal, transverse, rounded, and vertical fibers. The second division, called the extrinsic tongue muscles, connects the tongue with other parts of the mouth.

Besides the muscle tissues the tongue is made up of glandular material and in large part of mucous membrane structures. On the upper surface there are numerous small eminences called papillae. These important structures are of three general types. As Fig. 65 indicates, (1) the circumvallate type forms a sort of V-shaped line close to the base of the tongue; (2) the fungiform are numerous on the side and tip; while (3) the filiform and conical

[1] Living Machinery, Harcourt, Brace, 1927.

structures are unevenly distributed over its whole upper surface. The latter type of papillae is the most abundant of all. Imbedded in the fungiform and circumvallate papillae are the taste buds.

The presence of taste buds in the tongue suggests at once one of its functions. We might remind the reader of the great part the tongue plays in speech by referring to the convention of calling languages, tongues. Attention must be called also to the comparatively important food-mixing actions of the tongue in preparation for digestion.

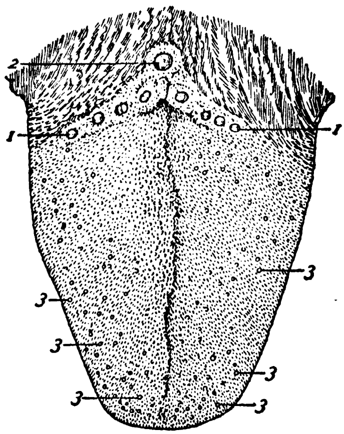


Fig. 65—Upper surface of tongue, 1, 2, circumvallate papillae; 3, fungiform papillae. From Angell, *Introduction to Psychology,* after Schafer, Holt, publishers.

The tongue then shows us that not only must one organ operate in conjunction with others of similar form, as we noticed in the case of the biceps muscle, but also that organs generally represent various kinds of structures and functions.

The Larynx

Because vocal speech occupies so large and striking a place in human behavior, the larynx or voice producing apparatus takes on great importance for the student of psychology.

The larynx makes its presence felt to anyone who touches the upper part of his neck while swallowing, and thus comes into contact with the Adam's apple or, as the Latinizing anatomist calls it, the Pomum Adami. For our present purposes it will be sufficient to point out a few features of this enormously complex organ.

The rigid structure of the voice box is made up primarily of nine cartilages, of which three are single and three paired. When we look at the front of the larynx as in Fig. 66 we see the cricoid (ring) cartilage surmounting the upper ring of the trachea. Above the cricoid cartilage and in articulation with it is the plate-like notched cartilage called the thyroid (shield). The third cartilage, the epiglottis, is indicated in Fig. 67, which shows also two of the

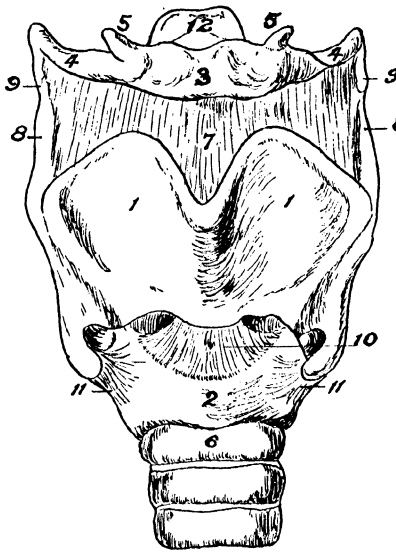


Fig. 66—The laryngeal cartilages and ligaments as seen from the front, Modified from *Quain's Anatomy*. 1, thyroid cartilage; 2, cricoid cartilage; 3, hyoid bone; 4, large cornua; 5, small cornua; 6, upper ring of trachea; 7, thyro-hyoid membrane; 8, lateral thyro-hyoid ligament; 9, triticea cartilage; 10, thyro-hyoid membrane; 11, lateral crico-thyroid ligament; 12, epiglottis.

three paired cartilages—namely, the arytenoids (spout vessels), and the cornicula of Santorini.

In Fig. 68 note the location of the third pair of cartilages—namely, the cuneiform cartilages of Wrisberg. Here are shown also the cornicula of Santorini, which appear as projections in the lower part of the drawings. This figure also shows the vocal cords or lips, and the glottis or opening between them. The vocal lips are attached in front to the thyroid cartilage and in back to the arytenoid cartilage. These lips may be regarded as stretched across the top of the larynx, and constitute the moving parts which make of the larynx the valve of the trachea.

The student of psychology is primarily interested in the larynx as a phonetic organ.. Accordingly we may consider its function to be the production of various sounds. The production of these sounds depends upon the condition and arrangement of the vocal lips. The different conditions of the vocal apparatus are indicated in Fig. 68. A shows the glottis as fairly closed, as in singing a high note. It is only when the cords are close enough together

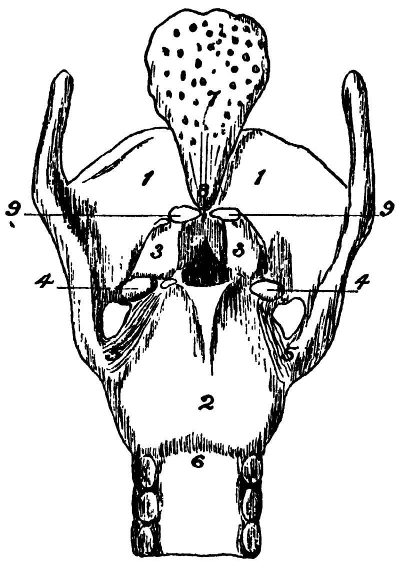
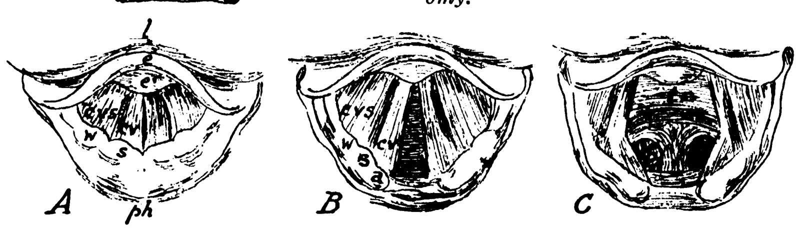


Fig. 67 (Left)—Harder parts of larynx as seen from the back. Redrawn from *Quain's Anatomy.* 1, thyroid cartilage; 2, cricoid cartilage; 3, arytenoid cartilages; 4, arytenoid muscles; 5, thyro-cricoid ligament; 6, upper ring of trachea; 7, epiglottis; 8, ligament connecting epiglottis and thyroid; 9, laryngeal cornicula or Santorini cartilages.

Fig. 68 (Below)—Various views of the upper part of the larynx as seen through the laryngoscope. A, the larynx while singing a high note; B, in quiet breathing; C, while inhaling a deep breath; 1, base of tongue; e, upper part of epiglottis; e′, cushion of epiglottis; ph, pharynx wall; w, swelling in membrane caused by cuneiform cartilage; s, swelling made by corniculum; a, tip of arytenoid cartilage; cv, vocal cord; cvs, false vocal cords; tr, trachea; b, bronchial tubes. From *Quain's Anatomy.*



to perform their reedlike vibrations that they can operate to produce sound. B represents the cords during quiet breathing, when only whispering can be produced. C shows the glottis at its widest, when no sound at all is forthcoming.

The various conditions of the vocal cords can be explained by the operation of the softer anatomical parts of the larynx, which consist of numerous membranes, ligaments, and muscles. Some

of the membranes and ligaments are represented in Fig. 68, and some of the muscles in Figs. 69 and 70.

The work of closing the glottis is performed by the group of sphincter laryngeal[2] muscles. There are three of these as seen in Fig. 70. As the name indicates, the thyro-arytenoid is attached to the thyroid and arytenoid cartilages. The contraction of this muscle-pair rotates the arytenoids inwards upon the cricoid upon which they rest, thus bringing the arytenoid cartilages together and closing the glottis. The lateral crico-arytenoids draw the arytenoids

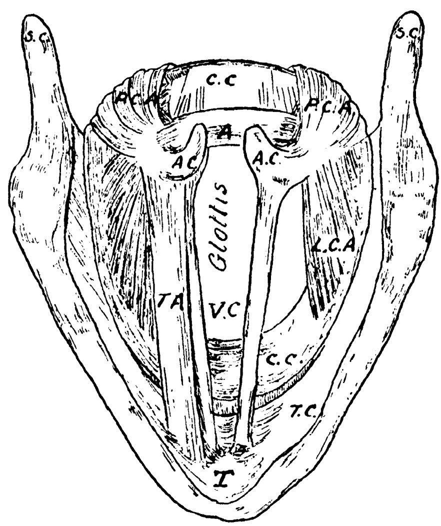


Fig. 69—Diagram of the laryngeal muscles and their cartilage connections. CC, cricoid cartilage; AC, arytenoid cartilage; TC, thyroid cartilage; SC, superior cornu; A, arytenoid muscle; LCA, lateral crico-arytenoid muscle; PCA, posterior crico-arytenoid muscle; VC, vocal cord; TA, thyro-arytenoid muscle; T, vocal cord attachment to thyroid cartilage. Modified from Müller.

forward and aid in bringing them together. And finally the inter-arytenoids connecting the two arytenoid cartilages serve directly to pull them together.

Antagonistic to the sphincter group is the dilator group. It is represented by the posterior crico-arytenoids. These draw the outer angles of the arytenoid cartilages inward and backward, thus widening the glottis.

[2] Students of the larynx do not all agree in their descriptions. The writer follows mainly Negus, The Mechanism of the Larynx, Heinemann, 1928.

Sound is described in terms of pitch, intensity, and timbre. It is thought that the first is produced by the length, tension, thickness, and breadth of the vibratory vocal lips. It is possible, too, that the variation in air pressure from the lungs has something to do with the pitch of sounds. Careful students of speech phe-

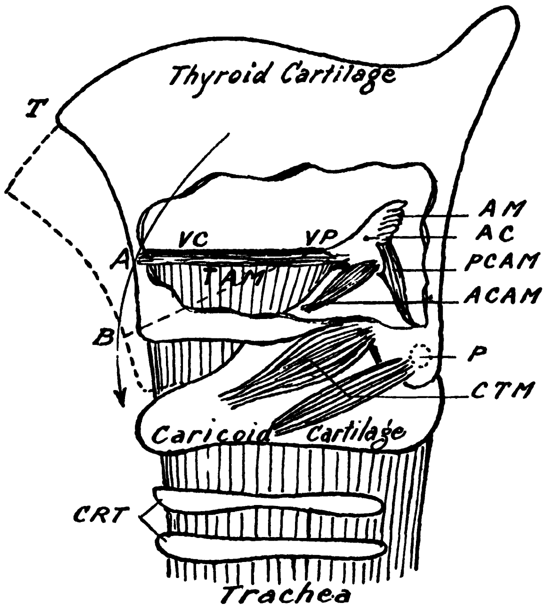


Fig. 70—Diagram of the larynx illustrating disputed classical theory of pitch. Left view with part of thyroid removed to show interior. VC, vocal cord; VP, arytenoid vocal processes; AM, arytenoid muscle; AC, arytenoid cartilage; PCAM, posterior crico-arytenoid muscle; ACAM, anterior crico-arytenoid muscle; P, where the thyroid turns pivotally upon the cricoid; CTM, crico-thyroid muscle; T, "Adam's Apple"; TAM, thyro-arytenoid muscle; A, B, indicate the movement of the point of attachment of vocal cord to thyroid; CRT, cartilage rings of trachea. From Allport, *Social Psychology*. By permission of, and arrangement with The Houghton, Mifflin Co.

nomena admit, however, that very little is actually known concerning the part played by the so-called vocal organs in speech. It is well to consider, too, that the whole subject is still couched in terms of organ functions. The neglect of the hypothesis that speech is an organismic interaction of the individual with speech stimuli may be responsible for this lack of information.

Pitch in its variations, according to a classical theory, is brought about by stretching the vocal cords or lips to make them thinner

and tenser. The thinner and tenser the vocal lips, the higher the pitch. This effect is produced primarily by the crico-thyroid muscles—short, thick, triangular muscles attached to the front of the cricoid cartilage and to the lower parts of the thyroid cartilage. When they contract, the thyroid cartilage is drawn away from the cricoid and arytenoid cartilages, and thus the cords are stretched. This action is diagramatically indicated in Fig. 70. We might add that when the arytenoid cartilages are braced back, the thyro-arytenoid muscles cooperate with the crico-thyroid to stretch the cords. Otherwise, the muscles are antagonistic to the crico-thyroids. Unfortunately the classical theory of longitudinal pitch, like so many others concerning the workings of the larynx, is vigorously disputed. It is asserted that tones may be raised a whole octave even when the thyroid cartilage is elevated instead of depressed.

Loudness or intensity is conditioned by the force of the air sent through the trachea by the lungs. This force controls the amplitude of the glottal vibrations.

Timbre or quality of vowel tones is based upon resonance effects brought about by changes in the pharynx, mouth, nose (head tones), and chest (chest tones). Of especial importance in the resonance of head tones are the shape of the mouth cavity, and the positions of the tongue, lips, and palate. The shape of the tongue, lips, and other features of the resonating mechanism produces and modifies overtones, which influence the timbre of the sound. Timbre or sound quality is also conditioned by the action of the diaphragm which changes the resonating character of the chest.

The student will, of course, not fall into the error of regarding the larynx as exclusively a phonetic mechanism. The vocal cords are not entirely vocal. There are animals with well developed larynxes that do not vocalize. The larynx, no more than the lungs or diaphragm, is a vocal organ, though all operate in sound making.

The Femur as an Organ of Anatomical Engineering

The casual student of biology may pass over the apparently simple bone structures as unattractive members of the anatomical family. For one thing, bones are to a great extent inorganic and only the products of living cells. But the student who sees all the organs in their inevitable interconnection in a unitary organization cannot help but admire the bony components of the organism as models

of anatomical engineering. Especially do the importance and perfection of bone come forcibly to the attention of the pathologist who observes the havoc played by bone diseases, such as tuberculosis and rickets, in support, leverage, and other functions.

We choose the femur, the long bone of the thigh, as a typical bone organ. The accompanying diagram (Fig. 71) represents the upper end of the femur upon which are drawn the lines of stress sustained by this bone in supporting the weight of the body. Although these lines were calculated mathematically, they conform in every detail to the body's actual construction. To quote Gamble,[3]

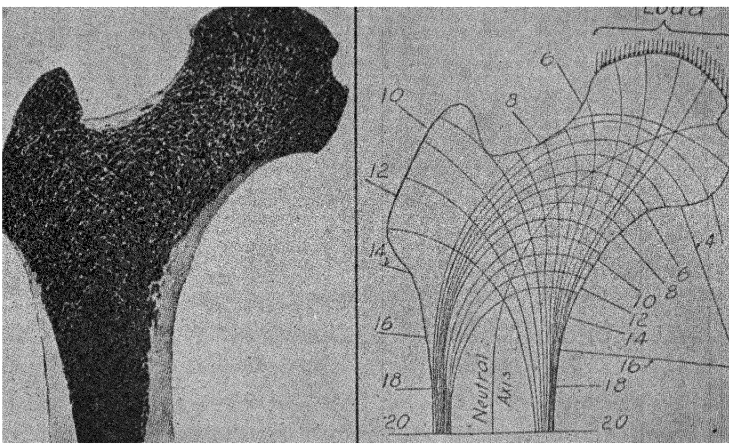


Fig. 71—Photographic reproduction of head and neck of femur bone with diagram showing mathematically calculated lines of stress. From Gamble, after Koch, in *Chemistry and Medicine,* The Chemical Foundation.

"they describe accurately its chief structural features; the hollow shaft and the 'spongy' bone of the head, the increasing thickness of the wall of the shaft and the relatively thin shell of the head." "The arrangement of the stone used in the construction of bone is, to the smallest detail, mathematically correct."

The Brain as a Neural Organ

The brain occupies a unique place in biological economy. It is one of the centralized organs. As the organism becomes more and

3 No Child Need Have Rickets, in Chemistry in Medicine, Chemical Foundation, 1928, p. 146.

more complicated, organs become increasingly necessary to coordinate the activities of the total individual. Generations of biologists have drawn an analogy for elementary students of the subject, between a telephone central with its communicating wires, and the brain with its pathways and nerves. This analogy has its good and bad points.

It is good when the central is taken to be like the modern automatic stations which are obviously only mechanisms for the interconnection of the various units of the whole system. The

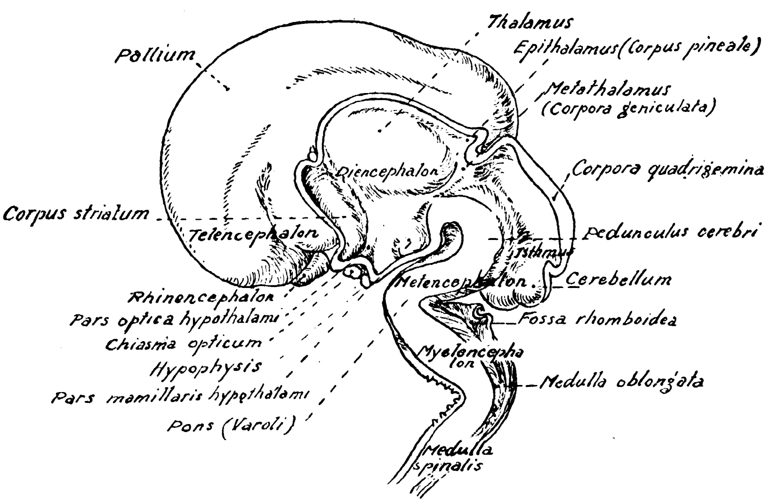


Fig. 72—A vertical median section brain model of human foetus in the third month. From Herrick (after His in Spalteholz's Atlas), *Introduction to Neurology,* Saunders, publishers.

analogy is entirely misleading when the system is supposed to carry messages or to be an instrument for determining or controlling what the organism does.

Gross Brain Structure.—As happens in so many cases of biological structure, the complexity of the brain can be effectively resolved by considering its embryological development. In Fig. 72 is represented a diagrammatic arrangement of the various parts of the foetal brain, which is divided off into five general divisions.

The (1) myelencephalon, comprising the medulla oblongata, represents the middle link between the spinal cord and the brain proper. (2) The metencephalon includes the pons varolii and the

cerebellum. The former of these consists of pathways to and from the cerebellum and other topographic regions of the brain. (3) The mesencephalon or midbrain is the lower portion of the brain stem, and comprises the cerebral peduncles and the corpora quadrigemina. Here there are pathways and points of connection (synapses) for neurons from the eyes, ears, and eye muscles. (4) The diencephalon or between-brain constitutes in large part the upper portion of the brain stem. The important structural feature here is the thalamus. This is the great relay station for all neural

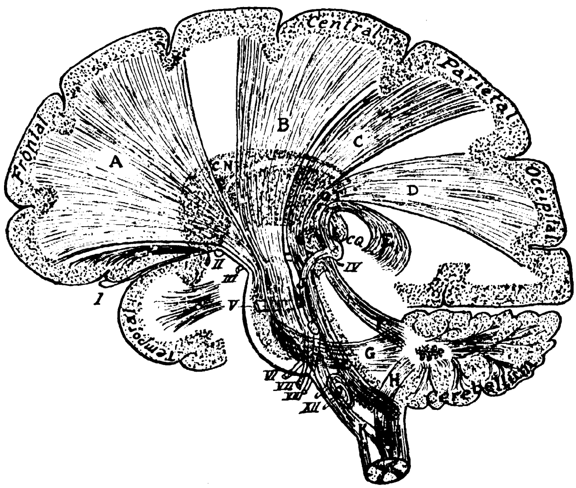


Fig. 73—Brain diagram to show cortical trunk lines. A, tract between frontal convolutions, pons varolii, and cerebellum; B, motor tract; C, somaesthetic tract; D, visual projection tract; E, auditory tract; F, superior cerebellar peduncle; G, middle cerebellar peduncle; H, inferior cerebellar peduncle; J, tract from auditory nucleus to inferior corpora quadrigemina; K, motor decussation in medulla; O, olivary body; CN, caudate nucleus; OT, optic thalmus; CQ, corpora quadrigemina; roman numerals indicate roots of cranial nerves. Modified from Starr.

impulses which pass upwards or forwards into (5) the telencephalon or end brain. The telencephalon consists primarily of the cerebral hemispheres, which are essentially fibers grown out of the brain stem. Here is the central switchboard apparatus proper.

Fig. 73 shows the arrangement of the great trunk lines of the cortex (cerebrum), the cerebellum, and the brain stem. These trunk lines are referred to as the great projection tracts. They consist of large bundles of fibers or neurons that enter and leave the brain and consequently carry impulses in and out of that organ. The specific tracts are indicated in the legend below the figure.

The tracts or neuron fiber bundles that connect the different parts of each hemisphere are called association tracts. (See Fig. 74.) This interconnection of the hemisphere parts is a necessary process in the integration of the organism's activities.

A third form of structure and function which makes for the unity of the organism is represented by the commissural fibers. There are many strands of such fibers connecting corresponding parts of the two hemispheres. Among these are the anterior, dorsal,

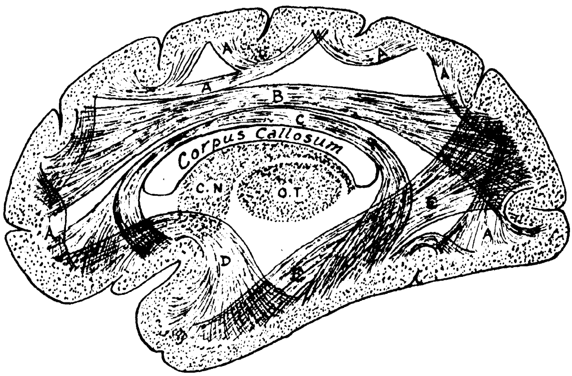


Fig. 74—Diagrammatic scheme of cortical association tracts. A, tracts between adjacent areas; B, tracts between frontal and occipital areas; C, D, tracts between frontal and temporal areas; E, tracts between occipital and temporal areas; CN, caudate nucleus; OT, optic thalamus. Modified from Starr.

and inferior commissures. The corpus callosum indicated in Fig. 74 is a striking example of such commissural fibers.

The distribution of the great pathways or fiber bundles in the hemispheres gives rise to the general external appearance of the brain. Everyone is familiar with the convolutions or folds of the hemispheres. In general the superficial anatomy of the brain can be described in terms of certain general landmarks. There is first the great longitudinal fissure, a cleft which divides off one hemisphere from the other. Next, a great cleft, the fissure of Sylvius, divides each hemisphere into a lower and an upper part. Then there is a large fissure which separates the front part of each hemisphere from the latter portion. This is called the central fissure or the fissure of Rolando. A less prominent fissure is found toward the rear or posterior portion of the hemisphere, called the parieto-occipital fissure, and there are others. These fissures serve to mark off the hemispheres into divisions called lobes. In Fig. 75

there are four of these indicated: (1) the frontal, (2) the parietal, (3) the occipital, and (4) the temporal. The fifth (5), called the central lobe, lies underneath and is not visible in the illustration.

The many convolutions of the hemisphere are called gyri. For example, the temporal lobes consist of a superior, a medial, and an inferior gyrus or convolution. These are horizontal gyri. The central or Rolando fissure is the boundary between the vertical precentral gyrus in front, and the postcentral gyrus in back.

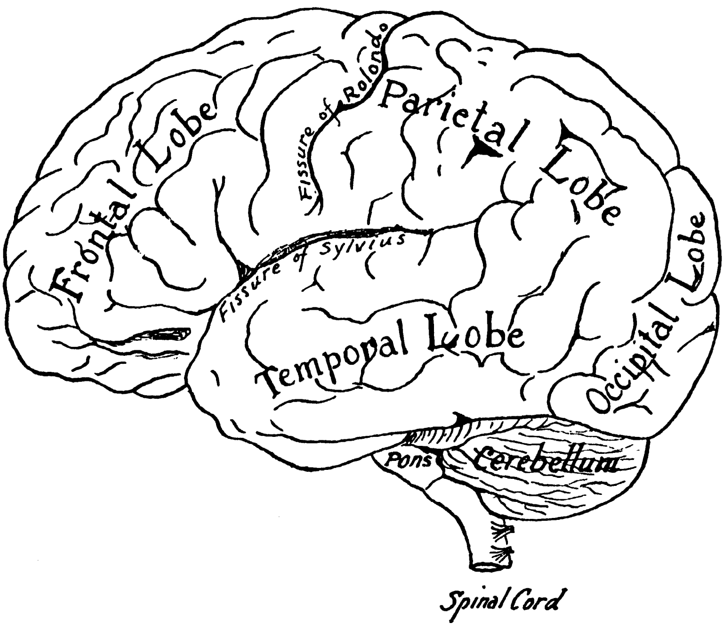


Fig. 75—Diagram of brain showing fissures, lobes, and gyri.

Histological Brain Structure.—Histologists have assiduously studied the finer structures of the brain; that is to say, its dendrons, cell bodies, and neural fibers. These scientists have not always been able to agree upon the actual architecture of that organ. The description of Brodmann, a German neurologist, may however be regarded as representative. This histologist divides the cerebral cortex into six main layers, though these layers are not found in exactly the same organization in all parts of the cerebral hemisphere. They may be briefly described as follows: (1) the outermost or plexiform layer consisting of small cell bodies whose den-

drons and axons do not pass out beyond this level, (2) a layer of small nerve cells, pyramidal in shape, (3) a layer of medium and large pyramidal cells, (4) a layer consisting primarily of fibers, (5) a layer of large cells typified by the giant pyramidal cells of Betz, (6) and finally a layer of many shaped cells.

Brain Function.—What does the brain do? "Why, the brain thinks," is the customary reply. The brain sends messages to the muscles notifying them what to do. To signify that one is incompetent or foolish is to say, "no brains." It is a conventional attitude to look upon the brain as the seat of psychic power. Indeed, the ascription of thinking to the brain is a fundamental characteristic of our modern civilization.

This conception of the brain may be traced back to Descartes, who proposed the idea that spiritual forces operate by moving the pineal gland. The ancient thinkers did not share this view. For example, the Greeks, represented by Aristotle, made the heart rather than the brain the seat of psychic powers. We still have a popular reminder of this fact in our phrase, "learning by heart."

We need only add that those psychologists who do not deal with psychic powers presumed to operate in conjunction with a body, do not regard the brain as a thinking organ. Is it possible that thinking is only a wraith-like process that "happens" when the brain is active? Thinking might actually be the complex interactional processes as delineated in Chap. 18.[4] We may also be reminded that there is a conflict here with the idea, discussed in Chap. 3, that no psychological phenomenon is merely the functioning of biological structures. It is questionable whether the mind—that is, psychological phenomena or behavior—is something that requires a seat or locus within the organism.

A variant of the conception that the brain is a thinking organ describes the brain as the controlling organ of the body. This view stands in sharp contrast to the interactional view, which regards psychological activities as complex ways of acting conditioned by

[4] We have already noticed in Chap. 16 that the conception of the brain as the organ of learning is based upon the assumption that the evolution of behavior parallels the evolution of the brain with its culmination in the human animal. Here the same assumption operates. Two questions are then in order. First, is the brain the only organ that shows the characteristic evolution, or is the whole organism so evolved? Secondly, does not the evolution of thinking behavior involve besides organic also cultural development?

past development and present stimulation. According to such a view the brain is only a centralized structure whose sole function is the integration and coordination of all the activities of the individual. Why should two kinds of functions, one psychological, the other biological, be ascribed to the brain or any other organ? From the organismic or interactional standpoint the brain is no more responsible for a person's activity than the heart, lungs, etc.

Of great interest to the student of psychology are the various grounds for believing in the primacy of the brain as an organ.

It is an old tradition that the size or amount of brain is the basis for intelligence and general psychological superiority. In support of this rationalization (for such is the view) the fact is cited that the human brain is the largest and heaviest. Only two types of living animals have heavier brains—namely, the whale, and the elephant. As the accompanying table indicates, the brain of the whale weighs 7,000 grams, that of the elephant 5,000 grams, while that of man is quoted as averaging 1,360 grams. But consider the ratio of brain weight to body weight. In the whale it is .01%, in the elephant, .02%, while in man it is 2%.

But looking at the matter a little more closely we find that it is a general rule that large animals do not perform complicated movements. They are not spry and agile. If the brain is a coordinating and integrating mechanism the matter is easily explained.

That this is a reasonable view is indicated by the fact that small animals, for example, mice, have brains weighing as much as 5% of their body weights. Are mice twice as intelligent as human beings, or is it true that a certain minimum amount of brain tissue is necessary for coordinating the activities of an organism?[5]

On the other hand, when we compare the brain sizes of dogs (120 grams), gorillas (400 grams), and men (1,360 grams) we find that the comparable body weights correlate with very different brain weights. Does this mean as some assert that we have here the basis for gradations in intelligence? Undoubtedly there is some connection between brain type and intelligence, but this need not be interpreted in any other way than that agility and speed of action are factors in psychological performance.

The danger of overstressing the close connection between brain size and intelligence is easily seen when we compare relative brain

[5] Cf. Parker, The Evolution of the Brain, in Human Biology and Racial Welfare, Chap. 4.

weights within the human family. When we consider that the average European male brain is placed at 1,360 grams and that of the female at 1,250 grams we might easily commit ourselves to the assumption of the absolute superiority of men over women. On the other hand, if we are dealing with ratios of body weight to brain weight, we notice that the woman would have an absolute advantage in that the average ratio for women is 2.3%, while that for men is only 1.9%.

Comparative Ratios of Brain Weights[6]

Animal	(grams) Body-Weight	(grams) Brain-Weight	%
Whale	70,000,000	7,000	.01
Hippopotamus	1,750,000	580	.03
Beaver	20,000	35	0.1
Elephant	2,500,000	5,000	0.2
Horse	300,000	600	0.2
Dog (very large)	46,000	120	0.2
Gorilla	90,000	400	0.4
Cat	3,500	30	0.8
Seal	26,000	300	1.0
Squirrel	400	6	1.5
European man	70,000	1,360	1.9
Monkey (macaque)	5,000	100	2.0
Mouse	10	.4	2.0
European woman	55,000	1,250	2.3
Harvest mouse	7	.35	5.0

A similar lack of correlation between brain size and intelligence is revealed when we examine the findings offered by students of brain measurements. These students find that the brains of equally eminent persons vary greatly from each other and from the quoted average of 1,360 grams. The brain of Cuvier, the French naturalist, weighs 470 grams above, while that of Anatole France weighs 343 grams below that average. It must be admitted, of course, that such measurements constitute something less than good evidence one way or another, since the brain like other tissue varies with age, bodily size, and other factors.

Faced by the difficulties here the believers in the conception of the brain as an organ of mind turn about and say that it is not

[6] Data from Ladd and Woodworth after Warncke, and from Parker.

the anatomical size or weight that really counts, but the finer structural organization. Certainly the human brain, for example, is more complicated than the brain of a lower animal. Such discrepancies are sufficiently accounted for by the differences in the general evolution and immediate life histories of human and infrahuman organisms. For example, the evolution and marine life of the whale certainly contribute to the size and weight of its brain, or rather have a great influence on its size and organization. But

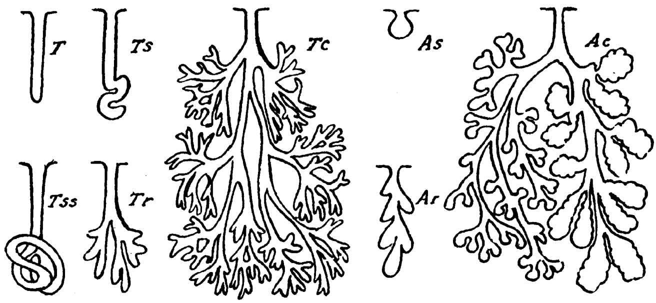


Fig. 76—Diagram of different forms of glands. T, simple tubular (intestinal glands); Ts, slightly coiled tubular (intestinal glands and small sweat glands); Tss, more extensively coiled tubular (larger sweat glands); Tr, branched tubular (gastric glands);Tc, compound tubular (kidney, lacrimal glands); As, simple alveolar or saccular (small sebaceous glands); Ar. branched alveolar (larger sebaceous glands, tarsal glands of eyelid); Ac, compound tubulo-alveolar or racemose (left) (salivary glands); compound saccular (right) (mammary gland). From Jordan, *A Textbook of Histology,* Appleton, publishers.

this hardly touches the question of the place of brain organization in the same or comparable species of animals. There is no evidence of any such differences in brain structure as between two normal human or other organisms of the same species.

The Glands as Organs of Secretion

The secretory processes going on in the manufacturing organs called the glands are exceedingly important in the economy of the organism. Anatomically, glands are pockets made up of epithelial tissue, arranged in all sorts of shapes. In Fig. 76 are shown the principal types of glandular structures, which are generally divisible into two great types, the tubular and the alveolar. The former are essentially tubes, either straight or bent, and sometimes arranged as complex branches. Alveolar glands are more like little sacks. They, too, are simple or compounded in various ways and are often treelike in their branching.

The substances manufactured in these glandular structures are disposed of in two ways. In some cases the secretion is conveyed through definite ducts. A typical example is the transportation of the salivary fluid from the parotid salivary gland to the mouth by means of the Stensen duct located below the tongue. Other glands discharge their secreted substance directly into the blood stream. Biologists accordingly distinguish between duct and ductless glands. The products of the latter are called internal secretions, so named by the great French physiologist Claude Bernard (1813-1878). Biologically the two kinds of glands are very different.

A. The Exocrines.—Duct glands are represented by a number of organs. We may first indicate (1) the salivary glands (compound tubular) of which there are three pairs—namely, the parotid, sub-maxillary, and the sublingual. These secrete saliva, of which one constituent—namely, ptyolin—acts digestively upon the starches. (2) A very familiar organ is the lachrymal gland, which secretes fluid for cleansing and lubricating the eye. (3) A third important series of glands is that found in the stomach and intestines, which supplies the various enzymes and other digestive substances. (4) The liver, too, which is the largest organ in the entire organism, secretes glycogen, urea, and bile, all important substances for the digestive and energy-producing functions.

B. The Endocrines.—Fig. 77 presents in diagram form the general location of the ductless glands. One of the best known glands of internal secretion is (1) the *thyroid*. This is a small organ (5 to 6 cm.) with two elongated oval lobes, one lying on each side of the trachea, close to the larynx. About 1914 Kendall, an American physiological chemist, isolated the peculiar hormonic product of this gland—namely, thyroxin. This chemical substance has a tremendous effect upon the metabolic functions. The absence of thyroxin, which contains iodin in its chemical make-up, interferes with the individual's growth.

Psychological literature contains considerable information about cretinism, a condition attributed to hypothryoidism or the insufficiency of thyroid functioning. The same condition in adults is responsible for a disease called myxedema, which induces skin thickening and drying, loss of hair, and extreme lassitude of behavior.

Hyperthyroidism or an overactivity of the thyroid gland produces opposite effects. When this condition is present the metabolic rate is greatly in excess of the normal, whereas in hypothyroidism it is correspondingly decreased. Among the effects produced is a disease called exophthalmic goitre, or Graves' disease. It is characterized by a highly increased metabolism, protusion of the eyeballs,

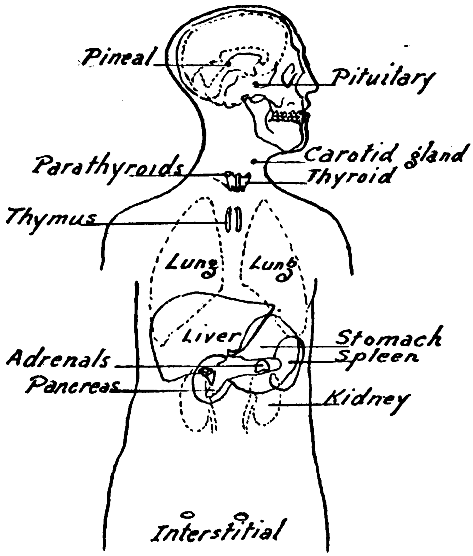


Fig. 77—Diagram showing location of glands of internal secretion. Modified from Barker, *Endocrinology and Metabolism,* Appleton, publishers.

restlessness, as well as an accelerated heart-beat and blood-pressure. Hyperthyroidism may lead to death from physiological exhaustion.

(2) Connected with the thyroid glands are four very small bodies called *parathyroids* which were first described by Sandström in 1880. The hormones of these glands produce their particular effects upon the calcium content of the blood. The importance of the parathyroids is indicated by the fact that calcium is a necessary factor in general muscular functioning, in blood clotting, and in bone building. As far as muscular action is concerned the complete removal of the glands results in tetany—painful spasmodic muscle contractions—which is fatal to the organism. The injection of the parathyroid hormone relieves the condition.

(3) Physiologists have suggested that the *thymus gland,* located below the thyroid, exerts a definite control over the young organism's growth. It is not clear, however, just what is the nature and mode of its operation, since the active principle has not yet been isolated. This fact allows the doubt whether it is an organ of internal secretion at all.

(4) The kidneys are capped with small organs called the *adrenal bodies* or suprarenal capsules, the great importance of which was first indicated by Addison in 1855 and by the French physiologist Brown-Sequard in 1856. The latter showed that removal of these bodies soon results in the death of the organism. The adrenal organs consist of two types of tissue, the medullary or chromaffin, and the cortical. Chromaffin tissue secretes an active principle which is variously called epinephrin, adrenalin, or adrenin. This hormone produces marked physiological effects. It accelerates the heart rate, increases blood pressure, and through its action on the vagus nerve greatly modifies respiration. A fundamental physiological effect of adrenalin is to regulate the organism's blood sugar. This result is brought about by the conversion of liver glycogen. Further, epinephrin or adrenalin produces marked effects upon the stomach and intestines as well as upon the spleen, the salivary and other glands. This hormone by its general stimulation of the blood circulation also functions to increase the red corpuscles of the blood.

The cortical hormone has recently been isolated by Swingle and Pfiffner, and by Hartman who suggests the name cortin for it. It is different in composition and function from adrenin. Physiologists are of the opinion that it is essential to life, but cannot agree upon its exact function. Three general theories, however, have been proposed concerning this hormone: (1) it prepotently regulates carbohydrate metabolism (Britton-Silvette), (2) it produces a general tissue effect (Hartman), and (3) it controls the circulatory blood volume (Swingle).[7]

(5) *The pituitary body* or hypophysis is an internal secretory structure attached to the lower part of the brain. Though the hypophysis is only the size of a small nut and weighs only about 0.6 gram it is made up of different types of tissue. Embryologically

[7] Britton and Silvette, Theories of cortico-adrenal function, *Science,* 1933, *77,* 366-368.

the pituitary body is of double origin. The first or anterior portion arises from the roof of the mouth and develops into three kinds of tissue, the anterior lobe, an intermediate lobe, and a smaller structure called the pars tuberalis. The second or posterior portion arises from the floor of the third brain ventricle, and forms the posterior lobe or pars nervosa, which as the name implies, is really neural rather than glandular in structure.

The known secretory materials of the pituitary body are believed to originate from two portions of the hypophysis.

The extract of the posterior lobe, which really comes from the embryologically different though structurally connected intermediate lobe, produces various effects upon the organism. The hormone called pituitrin or hypophysin stimulates smooth muscles, raises arterial blood pressure, increases and decreases urine secretion, and produces other marked physiological effects, especially upon the reproductive organs.

The anterior lobe of the hypophysis is believed to produce two general types of hormones. The first regulates the growth of the organism. Persons suffering from overfunctioning of this gland (hyperpituitarism) develop unusual height or what is technically known as giantism. In adult persons such overfunctioning produces acromegaly, a diseased thickening of the bones. An undersupply of this hormone (hypopituitarism) results in stunted growth. According to a recent report of the work of Evans of the University of California, an overproduction of the growth hormone produces diabetes.[8] The second type of anterior pituitary hormone stimulates the activities of the sex glands.

(6) The *pineal body,* also called *epiphysis cerebri,* like the hypophysis is an organ of the brain. It is an outgrowth, however, of the upper part of the brain structure. The functions of this organ are not very well known, but some physiologists believe that like the hypophysis it has something to do with the organism's growth and with sexual development.

(7) *The Islands of Langerhans* produce an internal secretion called insulin, which because of its importance in medical practice has recently stimulated a tremendous interest. This substance, which was isolated by Banting, Best, and Macleod in 1921, is secreted by tiny lobules isolated from other parts of the pancreas

[8] See Supplement to *Science,* 1932, 75, 1944, p. 10.

and hence called the islets of Langerhans, after the German histologist who first discovered them. The function of insulin is to regulate the amount of glycogen which the individual can transform into sugar. The pancreatic disease called *diabetes mellitus* consists essentially of an interference with the reduction of sugar, probably owing to the lack of regulation by the insulin hormone. The injection of insulin brings about a balance in sugar formation of the liver and its utilization by the organism.

(8) Both male and female reproductive (interstitial) glands secrete hormones which have definite effects upon the general physiological economy of the organism. The substances produced regulate the secondary sexual characteristics such as the amount and distribution of hair, anatomical size and shape, and other characteristics.

ORGANS OF DOUBLE SECRETION.—In view of the unitary character of the organism it is not surprising that there are organs which have a double secreting function. For example, the pancreas is not limited in its function to the secretion of insulin, but also secretes a fluid which is of great importance in digestion. Similarly, the stomach and upper intestine, which are always regarded as primarily exocrine organs, are also believed to secrete substances which are immediately absorbed in the blood stream. The liver, too, probably secretes an autocoid[9] as well as the exocrine bile fluid.

The Kidney as an Excretory Organ

For pedagogical purposes it is proper to describe the human organism as an engine into which fuel is placed, whose consumption leaves a residue which is excreted as waste products. The solid waste products are excreted by the peristaltic action of the digestive tract, and the gaseous by the lungs. Liquid waste products must be distilled out by other organs.

The kidney is a chemical excretory organ of this type. In shape it is a complex, bean shaped, tubular gland, which discharges through a large duct called the ureter (see Fig. 77). One of the primary functions of the kidney is to remove various substances from the blood stream which are finally excreted through the urinary tract.

[9] The term autocoid is the general name for the internal secretions. Some of these, the hormones, have an excitatory effect upon the organism while others, the chalones, inhibit functions.

Physiologists have isolated a large number of chemical compounds excreted by this organ. One of the best known is urea. In addition there are several substances called purine bodies, such as uric acid, xanthine, etc.

The Heart as a Circulatory Organ

Since Harvey (1578-1657) established the general facts concerning blood circulation, physiologists have been constantly accumulating new knowledge concerning this process. For our purposes it is necessary only to point out that the heart is a pair of force pumps lying side by side, and operating to force blood through the

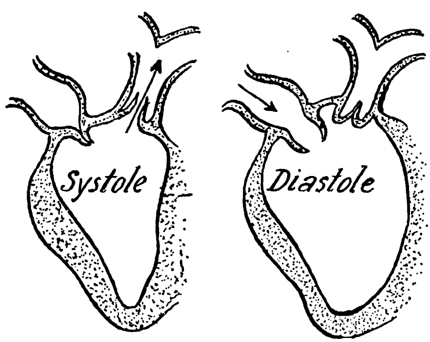


Fig. 78—Diagram showing valve action of heart.

arteries with unceasing energy. Thus the blood that goes out of the heart makes the rounds of the organism, carrying on its function of distributing nutritive substances and collecting waste materials.

The accompanying diagram (Fig. 78) shows the contraction of the auricles, which forces the blood through the ventricles into a large blood vessel. During this contraction the valve between the auricle and the ventricle is closed, so that the blood will flow in a single direction. This valve is opened when the blood flows into the ventricle.

The unitary character and functioning of the total organism cannot be better illustrated than by the heart and the circulatory function. Not only does the blood operate to carry foodstuffs and oxygen to the tissues, and eliminative substances from them, but it also transports autocoids. In short, the blood system operates in conjunction with all the other organs. Accordingly, Howell sug-

gests that the complete physiology of the blood system would be the physiology of the whole organism.

The Lungs and Respiratory Organs

The lungs comprise mainly a tree-like structure in which the twigs and branchlets consist of tiny alveoli or sacks. They are frequently compared with a pair of bellows because during the process of inhalation the whole chest cavity of the individual expands by the appropriate and conjoint operation of the bones and muscles of the chest, thus filling the lungs with air. The mechanism is diagramatically indicated in Fig. 79. Respiration is essentially the

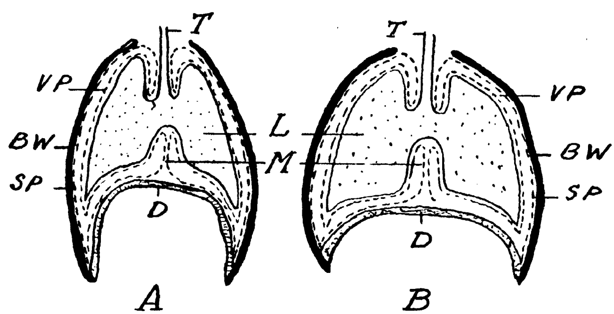


Fig. 79—Action of lungs within thoracic cavity. A, air expired by raised diaphragm and compressed ribs; B, air drawn in by lowered diaphragm and expanded ribs; BW, body wall; D, diaphragm; L, lung; M, mediastium; SP, somatic pleura; T, trachea; VP, visceral pleura. Modified from Walter (after Mollier). *Biology of the Vertebrates,* by permission of The Macmillan Co., publishers.

exchange of oxygen, contained in the air, for carbon dioxide, which is regarded as a waste product. The new oxygen taken into the lungs is passed on to the blood through the medium of many tiny vessels which come into contact with the lung structures. Here carbon dioxide is liberated into the air of the lungs and is then expelled.

The Stomach as an Organ of Digestion

Contrary to popular belief the stomach plays a rather minor part in digestion. Digestion is primarily a process of chemical transformation of ingested food substance. The stomach, which is essentially a sack, wide at one end and narrow at the other (diagram of its shape and location in rib cage, Fig. 77), serves primarily as a

storage and mixing chamber, whereas the thoroughgoing chemical operations, which are the fundamental digestive processes, take place in the intestines.

Receptors as Biological Organs

The anatomical organization of receptors is well known, but the exact way in which they function eludes the physiologist. In general, however, receptors serve as sensitive points of contact between the organism and stimulating objects or conditions. Herrick[10] divides receptors into two general classes: (1) the somatic and (2) visceral, the former involved in reactions to external stimuli, and the latter to the internal conditions of the organism. Each of these is in turn divided into two distinct subclasses as in the accompanying table.

TABLE OF RECEPTORS

Somatic Receptors	*Visceral or Interoceptive Receptors*
A. Exteroceptive	A. General Visceral
Involved in sensitivity to:	Involved in sensitivity to:
Pressure	Hunger
Touch	Thirst
Cold	Nausea
Warmth	Visceral Pain
Pain	B. Special Visceral
Hearing	Involved in sensitivity to:
Vision	Taste
B. Proprioceptive	Smell
Involved in sensitivity to:	
Muscular conditions	
Tendon "	
Joint "	
Static "	
Equilibration	

THE EYE AS A VISUAL RECEPTOR.—If we may compare the organism with mechanical objects we find a very striking resemblance between the human eye and a box camera. The eye ball corresponds to the box. As the conventional diagram illustrates (Fig. 80), it is made up of a heavy white sclerotic coat between

10 Introduction to Neurology, Saunders, (5), 1931.

which and the retina (corresponding to the sensitive plate) is a choroid or pigmented layer which we may regard as analagous to the light-excluding black paint of the camera wall. In front of the eye is found a diaphragm called the iris, which regulates the amount of light entering the eye.

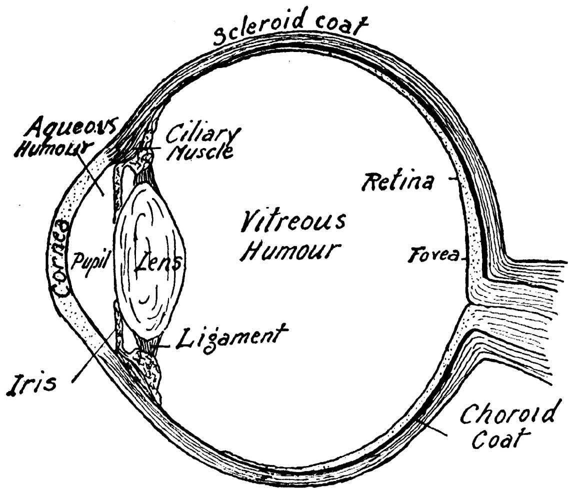


Fig. 80—Conventional diagram of eye.

As light passes into the eye through the cornea and the opening called the pupil, it goes through the aqueous humor before it impinges upon the lens which focuses the rays upon the retina. Between the lens and the retina is found the substance called the vitreous humor.

In addition to the structures already indicated we must call attention to muscles and ligaments which have to do with the accommodation and other optic functions of the eye. So far the visual organ is comparable to a camera from the standpoint of a light controlling mechanism, but here the superficial resemblances end. We pass over all the protective structures, eyelid, lachrymal glands, etc.

Physiologists regard the retina as the essential feature of the visual organ. A diagrammatic suggestion of the complicated organization of this structure is shown in Fig. 81. Notice the rods and cones, which are presumed to function in the discrimination of colors and brightnesses.

The Ear as the Auditory Organ.—In the human animal the external ear is of very little consequence. The essential receptor function is performed by the cochlea. Air waves enter the external canal of the ear, the meatus, and strike the drum membrane. The

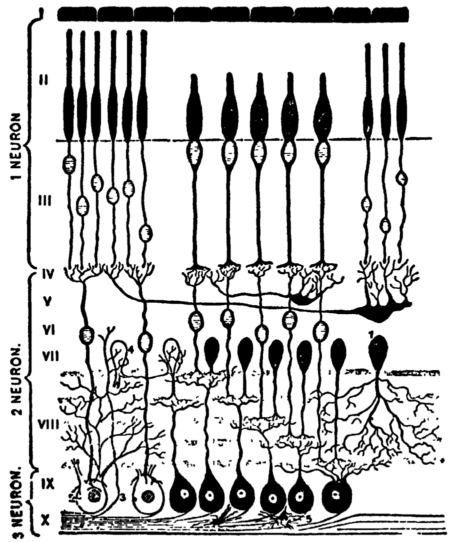


Fig. 81—Scheme of the detailed structure of the human retina. I, pigment layer; II, rod and cone layer; III, outer nuclear layer; IV, external plexiform layer; V, layer of horizontal cells; VI, layer of bipolar cells (inner nuclear); VII, layer of amacrinal cells (without axons); VIII, inner plexiform layer; IX, ganglion cell layer; X, nerve fiber layer. Modified from Howell after Greeff.

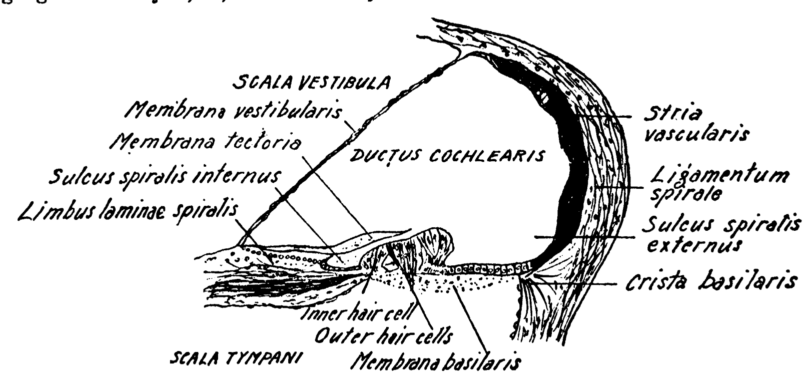


Fig. 82—Diagram of detailed construction of the inner ear, showing the organ of Corti.

vibrations then are transmitted to the internal ear by a series of bony structures called the anvil, hammer, and stirrup bones. This vibration is communicated to hair cells, located on the organ of Corti (Fig. 82) situated on the basilar membrane in the cochlea.

One of the theories suggested to explain the operation of the auditory receptor assumes that the fibers of the basilar membrane possess the capacity to vibrate sympathetically with the air vibrations of sounds. These sympathetic vibrations are communicated to the hair cells and result in a physiological change in the nerve cells, which finally reaches the brain. Another theory is that the tectorial membrane really is the resonating organ.

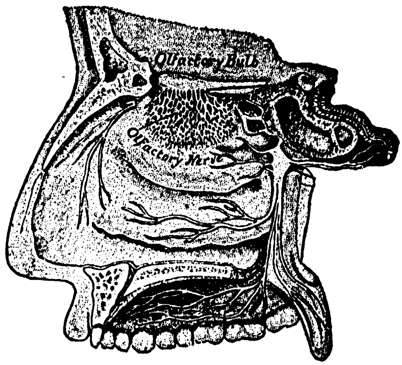


Fig. 83—Illustrating the olfactory bulb and nerve in their location in the lateral wall of the nasal cavity. From Herrick (after Woods, Reference Handbook of the Medical Sciences), *Introduction to Neurology*, Saunders, publishers.

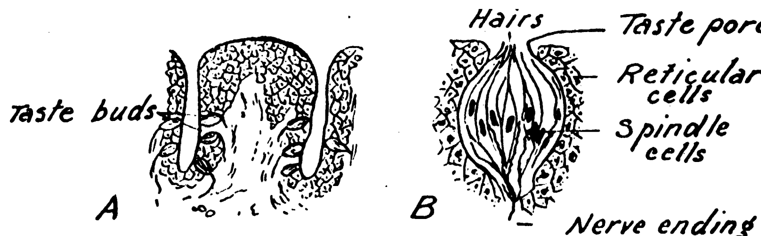


Fig. 84—The taste bud and its location in the papilla. A, diagram of a circumvallate papilla; B, drawing of a taste bud. From Walter, *Biology of the Vertebrates*, by permission of The Macmillan Co., publishers.

The entire resonator theory is opposed by some writers, who claim that the analysis of sounds is the function not of the peripheral receptor, but of the brain as a center. The central theory is called the telephone theory.

Olfactory Receptor Organs.—The olfactory receptor organ is located in the upper part of the nose, and consists primarily of sensitive cells set in a matrix of mucous membranes. Among the epithelial cells are located the dendrites of neurons, which convey impulses to the cortex of the brain. The pathway of these impulses through the openings in the ethmoid bone and the various relays in the olfactory bulb are shown in Fig. 83.

Gustatory Receptor Organs.—While discussing the tongue as a muscle organ we had occasion to point out that a number of the papillae contain taste buds. These are fairly complicated organizations of hair cells set in supporting cells connected with definite nerve endings. A taste bud and the way the buds are located are illustrated in Fig. 84 A and B.

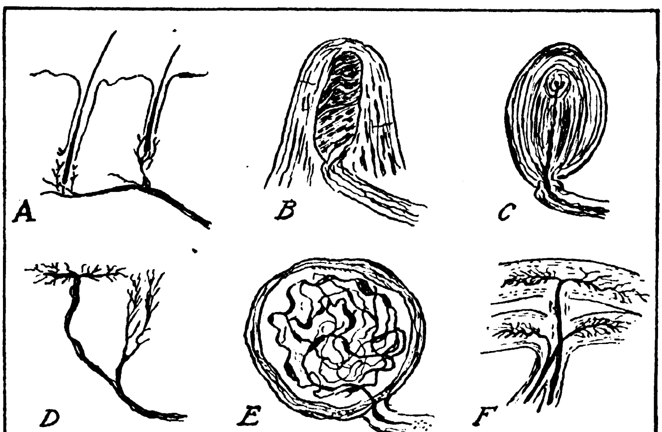


Fig. 85—Diagram of receptor organs. A, hair receptor involved with touch reactions; B, Meissner corpuscle involved with touch reactions; C, Pacinian corpuscle involved with deep pressure reactions; D, free nerve endings involved with pain reactions; E, Krause end-bulb involved with cold reactions; F, Ruffini end-organ involved with warmth reactions. Modified from Lund, *Psychology*, Seiler, publisher.

The Cutaneous Receptor Organs.—Distributed throughout the skin are a large number of organized structures which are presumed to operate in specific types of contacts of the organism. Many of these are named after the histologists who first described them or made them known. In Fig. 85 is diagrammed a series of these organs with an indication as to the type of stimulus

to which they are sensitive. Especially to be noted are the unique, free, nerve-ending receptors distributed throughout the skin tissues without any further organized structures. Evidence is available indicating that the correlation of structure and function with respect to these organs is not entirely settled.[11]

Effector Organs

Organologists point out that effectors correspond anatomically to the receptors, but are found at the opposite end of the nerve pathway. On the physiological side neural impulses originate in the receptors and discharge through effectors into muscles or glands.

Fig. 86—An effector organ. Drawn from a Kulchitsky microphotograph of muscle fibers with motor end-plate. From Hill, *Living Machinery.* Harcourt, Brace, publishers.

Fig. 86 indicates an effector organ distributing its neural discharge into a muscle organ. Effector organs are classified as somatic when located on striated muscle fibers, and as visceral when located on smooth muscles and glands.

[11] See Pendleton, C. R., The cold receptor, *Am. J. Psych.,* 1928, 40, 353-371; and Dallenbach, K. M., The temperance spots and end organs, *Am. J. Psych.,* 1927, 39, 402-427.

CHAPTER XXIV

THE NERVOUS AND OTHER BIOLOGICAL SYSTEMS

Organs Constitute Systems

The highest members of the conventional biological hierarchy consist of a series of systems. These systems go to make up the complete animal, and are composed of organs in various combinations. The following list of systems usually described by biologists is arranged partially on an anatomical, and partially on a physiological basis.

Integumentary	system
Skeletal	"
Muscular	"
Digestive	"
Respiratory	"
Circulatory	"
Excretory	"
Reproductive	"
Nervous	"

To discuss these systems at length would carry us far beyond the proper limits of this book. We propose, therefore, merely to suggest the general organization and operation of the individual as a biological being. It may be well, however, briefly to characterize the systems enumerated, and to point out their essential nature by describing in some detail the nervous and circulatory systems.

Integumentary System

The cells, tissues, and organs of the skin all operate as one unit to carry out the skin functions. Moreover, there is an absolute interrelationship of the specific skin tissues with the receptor organs, glands, and nerve fibers distributed throughout the integumentary system.

Skeletal System

The accompanying diagram (Fig. 87) pictures the relative positions and articulations of all of the bones in the entire skeletal system. It is hardly necessary to emphasize the total integration of

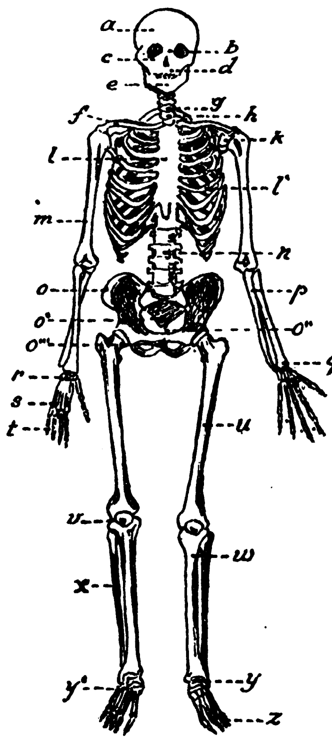


Fig. 87—Bones of the skeletal system. a, frontal bone; b, nasal bone; c, zygomatic bone; d, maxilla; e, mandible; f, clavicle (collar bone); g, 7th cervical vertebra; h, 1st thoracic vertebra; k, scapula; l, sternum; l′, rib; m, (arm) humerus; n, lumbar vertebra; o, illium; p, ulna; q, radius; o′, sacrum; o′′, coccyx; o′′′, pubis; r, (wrist) carpal bones; s, metacarpal bones; t, (phalanges) bones of fingers; u, femur (thigh); v, patella; w, tibia; y, talus; y′, metatarsal bones; z, (phalanges) bones of toes. From Stopes, *The Human Body*, courtesy of G. P. Putnam's Sons, publishers.

each bone with every other in the intact normal organism. To consider the leverage, supporting, and articulating functions of the system is to suggest at once the interrelationship between the bones.

tendons, and ligaments. Tendons serve as intermediate links between the skeletal and muscular systems, while ligaments operate to articulate the bones.

Muscular System

Each of the 600 muscles (some of which are shown in Fig. 88 A and B) in the body operates in conjunction with every other one in a most subtle team-play to bring about the various action patterns of the organism. Some of this activity is excellently illustrated in the antagonistic workings of the muscles. To carry out the animal's action patterns it is necessary that positions be maintained as well as movements made. In themselves, however, muscles perform only one function—namely, pulling when they contract. Each pull on a bone accordingly is compensated for by a conjoint pull in the opposite direction. When muscles cooperate in this way they are paradoxically called antagonistic.

Consider the action of standing upright. There are contractions of extensor muscles which cooperate with the contractions of the opposing flexors, so that the organism is in a state of delicate balance and ready to respond to new stimuli with new response configurations.

The integrative character of the muscular system is further indicated by its work in contributing to the circulatory, respiratory, and digestive functions. The muscles functioning in breathing (inspiration and expiration) serve to raise and lower the ribs or chest bones and move the diaphragm up and down, thus enlarging and contracting the chest cavity. Muscular activity functions likewise in the blood vessels during circulation, and in the alimentary tract during digestion and excretion.

Excretory System

The lungs, colon, kidneys, and the skin all constitute structuro-functional units of the excretory apparatus. The wide distribution of the organs concerned and their apparent divergence of function emphasize the organismic character of living things. The operation of the excretory system eliminates the gaseous, solid, and liquid waste materials, thus fostering the continued existence and well-being of the animal.

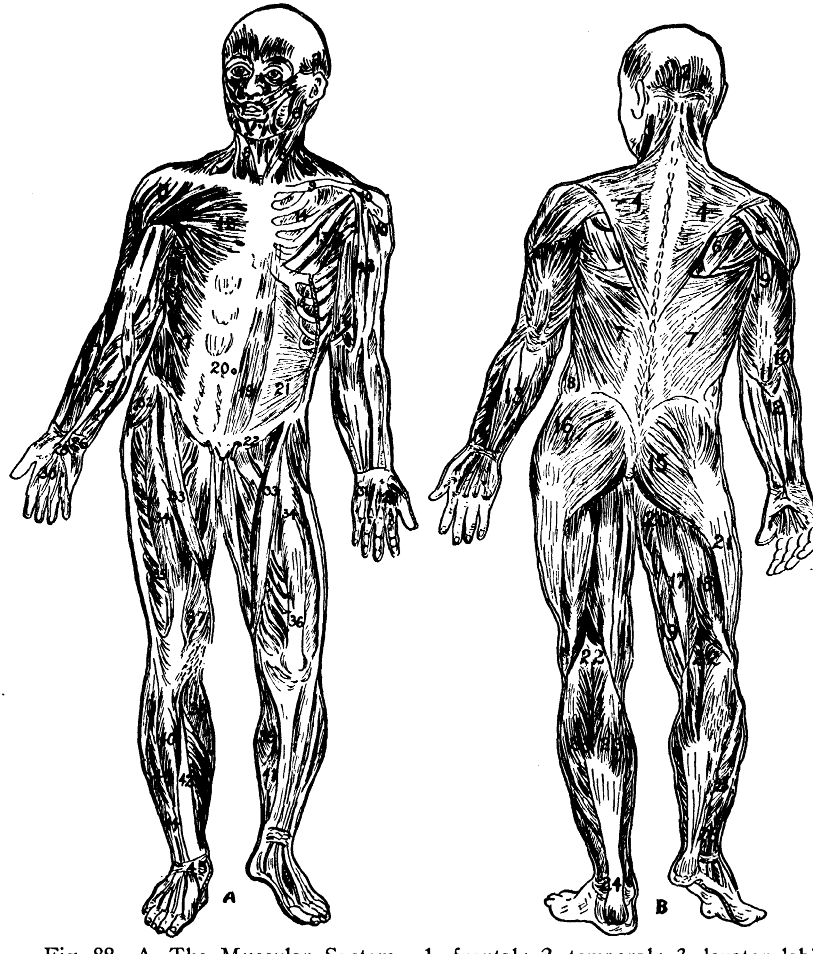


Fig. 88—A. The Muscular System. 1, frontal; 2, temporal; 3, levator labii superioris alaeque nasi; 4, orbicularis palpebrarum; 5, zygomaticus; 6, masseter; 7, orbicularis oris; 8, sternocleidomastoid; 9, clavicle bone; 10, scapula bone; 11, deltoid; 12, pectoralis major; 13, pectoralis minor; 14, intercostal; 15, tendon of long head of biceps; 16, serratus anterior; 17, obliquus abdominis externus; 18, rib cartilages; 19, rectus abdominis; 20, umbilicus; 21, obliquus abdominis internus; 22, inguinal ligament; 23, biceps; 24, supinator longus; 25, palmaris longus; 26, annular carpal ligament; 27, flexor carpi ulnaris; 28, insertion of palmaris longus; 29, flexor brevis pollicis; 30, tendons; 31, opponens of little finger; 32, tensor fasciae latae; 33, sartorius; 34, rectus femoris; 35, vastus lateralis; 36, tendon of femoral quadriceps; 37, vastus medialis; 38, gastrochnemius; 39, gastrochnemius; 40, tibialis anticus; 41, soleus; 42, tibia bone; 43, long extensor of toes; 44, peroneus tertius; 45, annular tarsal ligament.

Fig. 88—B. The Muscular System. 1, temporal; 2, occipital; 3, sternocleidomastoid; 4, trapezius; 5, deltoid; 6, infraspinatus; 7, latissimus dorsi; 8, external

Digestive System

The story of how each part of the organism indispensably cooperates with every other in carrying on its activities can be excellently told by describing the operation of the digestive system. In order to digest, the organism must first procure food and place it into the mouth, which may be regarded as the first organ concerned in the chemical activities of digestion. The teeth tear and otherwise partition the food in preparation for the operation of the salivary fluids. The tongue, too, must be regarded as a digestive organ in manipulating the contents of the mouth. The next step is the operation of the œsophagus with all of the organs and functions necessary for swallowing, and the passage of food down to the stomach. Of that organ's digestive activities we have already spoken. The next stage is the manipulation and chemical transformation of the food substances in the small intestine. Besides the intestinal juice supplied by the intestine itself, pancreatic juice and bile are poured into the intestine from the pancreas and liver. Finally, the capillaries of the blood system absorb the transformed chemical materials. The digestive system also includes, of course, the large intestine, which continues the work of the small intestines and in addition receives and excretes indigestible material.

Circulatory System

Biologists generally believe that living things originated in water. From this fluid environment organisms derived their nutrition and delivered to it their wastes for disposal. Moreover the conception still prevails that the cells of the complex organism are still fluid-living objects. But now the fluids which are necessary to support organisms in their remote and protected habitats consist of blood and lymph. In order that these fluids should be able to carry out their functions effectively they must be in continuous and frequent circulation. Physiologists estimate that only 20 to 30 seconds are required for this circulation to take place, and thus it occurs from three to four thousand times a day.

In consonance with the old conception of controlling masters and executing servants, physiologists assert that the circulation of the blood is primarily the work of the heart, which, by its pumping action, forces blood into the arteries to begin its round of the organism.

But there are other organs and functions that cooperate in this enterprise. In the first place, there is the elaborate conduit system represented by the arteries, veins, and capillaries. Arteries and veins have elastic walls, which by enlarging and contracting their diameters, aid in keeping the fluid they contain upon its journey.

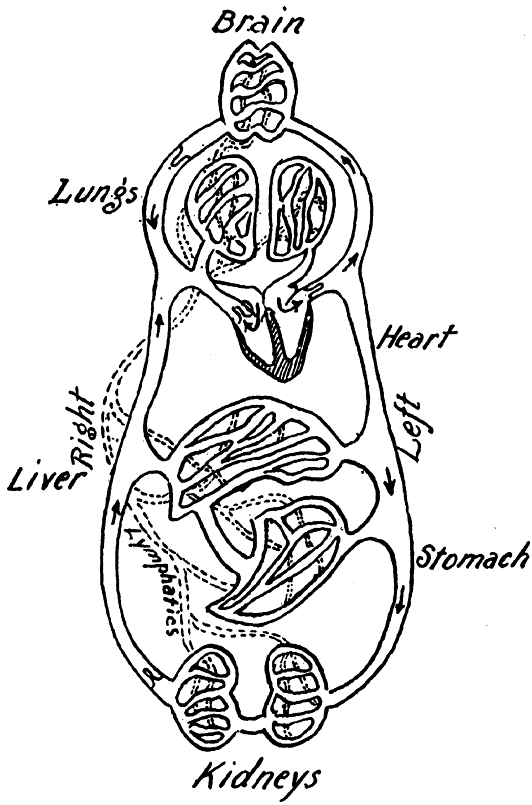


Fig. 89—Diagram showing part of the circulatory system. Blood vessels represented by solid lines, lymphatics by dotted lines. General description in text.

Secondly, we must notice, too, that the veins like the heart are supplied with valves which keep the blood going forward. In the third place, respiratory movements have a marked influence upon blood circulation. As Howell puts it, "the main effect of the respiratory

movements is to force or to suck blood from the large veins of the abdomen and neck into the large thoracic veins, and, therefore into the right side of the heart." Fourthly, the contraction of muscles generally forces the blood from the capillaries and veins lying between them into the larger veins. On account of this muscle activity Cannon refers to the muscles concerned as outlying hearts.[1] The alternate flexions and extensions of the joints similarly aid in the circulation of the blood. And finally, the work of the capillaries themselves must be stressed. Although the role of the capillaries may be regarded as primarily metabolic, still they must be thought of as performing important circulatory functions.

In Fig. 89 is a diagram indicating the general course of blood circulation. The student will notice that the essential features here are first the forcing of blood from the left ventricle into the aortic artery, from which it goes to the various organs such as the brain, stomach, liver, etc., and is further distributed throughout the organism by means of the smaller arteries and capillaries which lead off from the large arteries. This blood is then collected from all the different tissues, passed through the right auricle into the right ventricle, from there is pumped through the lungs where the impurities are discharged, and finally is brought through the left auricle to the left ventricle for a repetition of the process.

Nervous System

While discussing the brain as a neural organ we have already described its structure and function as a member of the biological household. It remains then to indicate its place in the system which constitutes the nervous department of the organism.

As we all know, the nervous system is the organism's great integrating mechanism. We need not, of course, regard it as the only integrating system. For example, Cannon says,[2] "In each instance it is clear that an organ in one part of the body has remote effects on parts far removed from it. The connecting agency is not the nervous system, but the other great integrating system of the organism, the circulating blood and tissue fluids." We may, however, point out that, while the blood system has other than integrat-

[1] The Integrative Action of the Vascular System, in Human Biology and Racial Welfare, 1930, p. 237.

[2] Ibid, p. 244.

ing functions it is the neural system that operates essentially to make the organism act as a single unit or totality.[3]

This being the case it is clear that in order to carry out its function the nervous system must be completely distributed throughout the organism. The neural tissues must then be organized in the

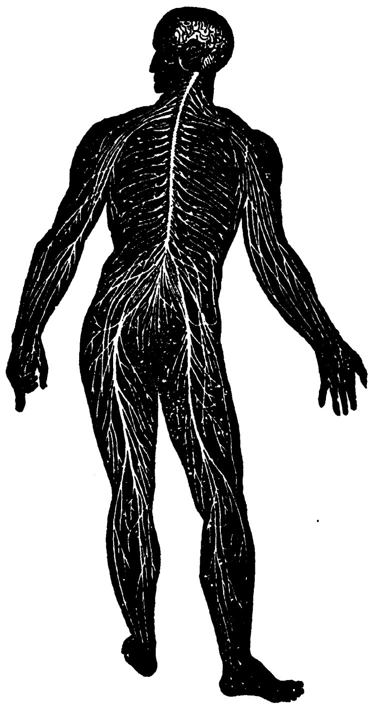


Fig. 90—The nervous system of man. From Martin, *Human Body*, Holt, publishers.

form of tracts, relay stations, and central organs, so that impulses can be conducted from each part to every other part. Fig. 90 shows in diagrammatic form this general distribution of neural cells, tissues, and organs.

Neurologists usually describe the action of the nervous system as though the organism always begins to act from a state of com-

[3] Perhaps we should say that the vascular system more particularly integrates the organism as a self-contained unit, while the nervous system, at least the central and peripheral parts, integrates the organism for purposes of reacting to external conditions.

plete rest or inaction. This is not the case. The organism really does not adjust itself to discrete situations. Rather, each interaction is a change of activity, a process of adapting itself to new objects and conditions.

In accordance with the start-from-rest conception neurologists have assumed that the nervous system begins to act merely by the physiological stimulation of a receptor. The hypothetical single impulse thus set up has been traced to the brain over a sensory or afferent pathway and then back to a muscle or a gland. We may be certain that a statement so abstract hardly does justice to an exceedingly complex happening,[4] but it does help us to describe the nervous system, which is so complicated as otherwise to defy analysis. Keeping in mind, then, that this is a dissection attitude we can summarize the gross structures of the nervous system as follows:

Anatomists generally divide the nervous system into two parts, (1) the central or axial nervous system, consisting of the brain and spinal cord, and (2) the peripheral nervous system, which includes the nerves both cranial and spinal, the ganglia, and the autonomic system. For our purposes we can analyze the nervous system into a series of connecting mechanisms.

A. The Central or Axial System

THE BRAIN.—(a) *The coupling of receptors and the brain.* Neurologists trace out a visual, an auditory, an olfactory pathway, etc. These are cephalic or head connections. Receptors distributed throughout the skin in all parts of the periphery or outlying districts of the animal are also connected with the brain. The neurons of these pathways have relays not only in the brain stem, as is the case with the cephalic pathways, but also in the spinal cord and medulla. All connections under (a) are ordinarily referred to as sensory or afferent pathways. Fig. 91 is a diagram of the chief ascending tracts.

(b) *The coupling of various parts of the hemisphere.* In discussing the brain we have indicated that many of the neurons making up that organ connect various parts of each hemisphere (ipsilateral or association fibers), while others connect the two hemispheres (commissural or contralateral fibers). There are similar

[4] The more recent notion of volleys of impulses is just as objectionable.

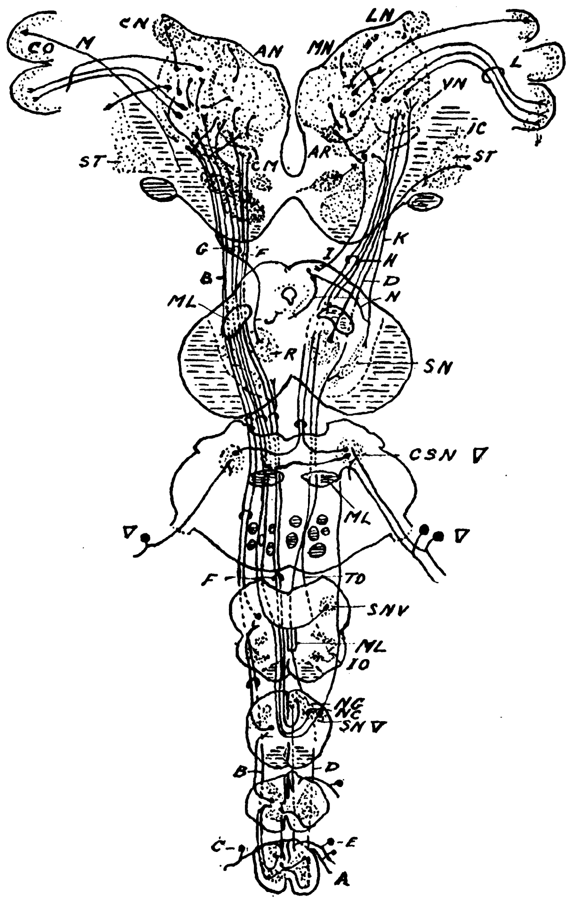


Fig. 91—Diagram of chief ascending neural tracts. A, neuron involved in pain or temperature reactions; AN, anterior thalamic nucleus; AR, arcuate nucleus; B, lateral spino-thalamic tract; C, neuron carrying tactile impulses; CM, centromedian nucleus of Luys; CN, caudate nucleus; CO, cortex; CSN V, chief sensory nucleus of the fifth nerve; D, ventral spino-thalamic tract; E, proprioceptive neuron; F, proprioceptive portion of medial lemniscus; G, ventral trigeminal lemniscus; H, dorsal trigeminal lemniscus; I, incerto-tectal tract; IC, internal capsule; IO, inferior olivary nucleus; J, incerto-rubral tract; K, strionigral tract; L, thalamo-cortical tract to postcentral gyrus; LN, lateral thalamic nucleus; M, cortico-spinal tract from precentral gyrus; ML, medial lemniscus; MN, medial thalamic nucleus; N, crossed and uncrossed tecto-spinal tracts; NC, nucleus cuneatus; NG, nucleus gracilis; R, red nucleus; SN, substantia nigra; SN V, spinal nucleus of the fifth nerve; ST, striatum; TO, thalamo-olivary tract; VN, ventral thalamic nucleus. From Herrick (after Huber and Crosby), *Introduction to Neurology,* Saunders, publishers.

relay connectors in the spinal cord and in every division of the neural system.

(c) *The connection of the brain with the muscles.* From the different parts of the central system there are tracts to the periphery.

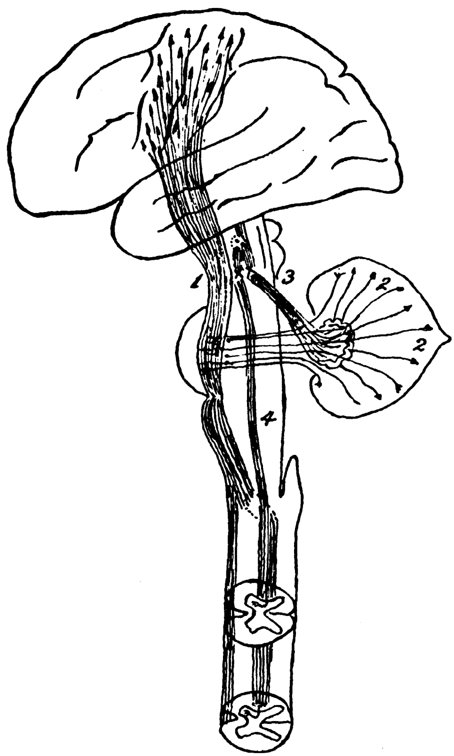


Fig. 92—Illustrating the descending neural tracts. The path is indirect and comprises the following units: 1, the cortico-ponto-cerebellar path, represented as arising in the motor area of the cerebrum and passing down with the pyramidal system to end in the pons, thence continued through the middle peduncles to the cerebellar cortex of opposite side. 2, the path from the cerebellar cortex to the dentate nucleus. 3, the path from the dentate nucleus to the red nucleus, passing by way of the superior peduncles, brachium conjunctivum. 4, the path from the red nucleus to the motor cells of the spinal cord (rubrospinal tract). From Howell, after Van Gehuchten.

An important example is the pyramidal pathway from the so-called motor cortex to the skeletal muscles. This is regarded as the great through efferent pathway, but there are others from the cortex and

from relay stations (nuclei) in all parts of the nervous system. A diagram showing a through pathway is indicated in Fig. 92.

(d) *The connection of the viscera with the axial system.* Since the organism is a unit in every respect, there are various tracts running to the viscera or the internal organs (heart, lungs, intestines, etc.). This part of the nervous system has been isolated as a sepa-

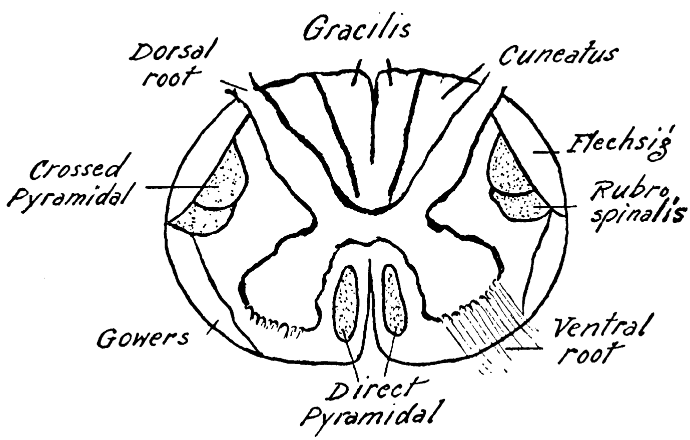


Fig. 93—Diagram of a cross-section through the spinal cord. Ascending tracts are plain while descending tracts are dotted.

rate division and variously called the sympathetic, autonomic, or splanchnic system.

The Spinal Cord.—Below the brain and as a definite continuation of it lies the spinal cord. In its gross structure the spinal cord represents a continuous thinning of the hind brain or medulla, which in the upper neck region of the human adult reaches a thickness of about the size of the little finger, and continues down to the lower part of the back. The spinal cord lies in the tube formed by the vertebrae of the spinal column.

Like the brain the spinal cord is made up of white and grey matter. The white matter consists of neural fibers which run up and down the length of the cord with various relays, while the grey matter in the shape of an irregular figure H lies within the white matter and, of course, consists of cell bodies and uncovered fibers.

Neurologists have been able to work out in the white matter definite series of tracts or bundles which serve in the conduction

of impulses up and down the cord. In Fig. 93 are represented some of the most prominent of these pathways. Attention is especially called to the Fasciculus gracilis, the Fasciculus cuneatus, and the Fasciculus cerebello-spinalis (direct cerebellar, or Flechsig tract) among the ascending bundles carrying tracts to the brain, through relays, of course. In the descending series we indicate the Fasciculus cerebro-spinalis lateralis, the crossed pyramidal tract, and the Fasciculus cerebro-spinalis anterior, regarded as the chief direct descending pathways. As the student will observe, the tracts and bundles are named to show the points of origin and discharge of impulses, the point of origin coming first in the name.

As Fig. 93 shows, the grey matter is much thicker on the ventral or anterior side. Here are concentrated the cell bodies of the efferent fibers which go to make up the motor nerves. On the dorsal or posterior side the grey matter forms a horn which is much thinner, because this part of the spinal cord consists of fibers which have their cell bodies located in ganglia outside of the spinal cord.

The horns of the grey matter of the spinal cord give rise to thirty-one pairs of spinal nerves situated at the various levels of the cord, which distribute their fibers for the incoming and outgoing impulses all over the periphery of the organism and connect with fibers going to the viscera inside the body wall.

B. *The Peripheral System*

THE NERVES.—There are 43 pairs of nerves, of which 12 pairs are cranial and 31 spinal. These operate in the transmission of impulses from the receptor organs in the periphery to the central nervous system (afferent, sensory, or centripetal nerves), and from the central nervous system to the periphery (efferent, motor, or centrifugal nerves). The biological organization of these nerves according to their pathways and functions follows:

a. *Cranial Nerves.*

No.	Name	Function
I.	Olfactory	Sensory from nose for smell
II.	Optic	Sensory from eye for vision
III.	Oculo-motor	Motor to and sensory from eye-muscles
IV.	Trochlear	Motor to and sensory from eye-muscles
V.	Trigeminous	Sensory from skin, mouth, and teeth, motor to jaw muscles

VI. Abducens	Motor to and sensory from eye-muscles
VII. Facial	Secretory to salivary glands and motor to facial muscles, sensory from viscera, anterior tongue for taste, and skin of external ear
VIII. Auditory	Sensory from ear for hearing and equilibrium
IX. Glosso-pharyngeal	Motor to salivary glands and to pharynx, sensory from posterior tongue for taste, from pharynx, from external ear
X. Vagus	Motor to viscera, and sensory from pharynx, thorax, abdomen, external ear, and from epiglottis for taste
XI. Spinal accessory	Motor to pharynx and shoulder
XII. Hypoglossal	Motor to tongue

b. *Spinal Nerves.* Concerning the spinal nerves we can only say that they enter and leave the spinal cord by means of the ventral and dorsal roots. The motor nerves are extensions of the former and the sensory nerves of the latter. These nerves carry impulses to and from the viscera and the peripheral regions of the organism. Of the spinal nerves 8 pairs are cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.

THE AUTONOMIC NERVOUS SYSTEM.—Fundamentally the autonomic nervous system operates in the coordination of the activities of the visceral organs. Its general location and relation to the cerebrospinal system as well as to the organism as a whole is indicated in Fig. 94. It operates also to integrate the visceral functions with the general behavior of the individual, especially while performing affective patterns of action. Physiologists correlate autonomic nerve function with the activities of the digestive apparatus, changes in heart beat and circulation, the secretion of sweat, temperature regulation, the appearance of goose flesh, and the erection of hairs.

Anatomically the autonomic system can be analyzed into four general divisions, (1) cranial, (2) sympathetic, (3) sacral, and (4) enteric. (1) and (3) are also referred to as the parasympathetic, while (4) is sometimes called the visceral autonomic nervous system.

Biologists generally neglect to consider the pathways of the afferent impulses from the visceral to the central neural organs. Some of these are indicated in Fig. 95. This circumstance can probably be explained by the fact that they have held too closely

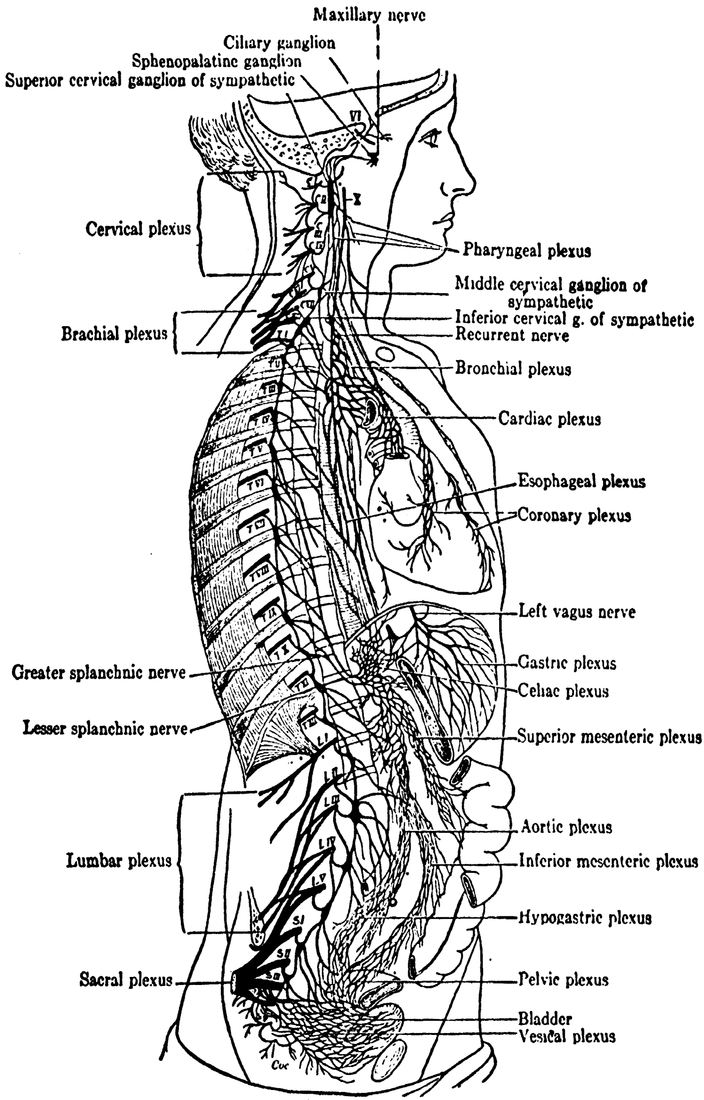


Fig. 94—Showing autonomic nervous system and its distribution in the organism. From Herrick (after Schwalbe), *Introduction to Neurology,* Saunders.

to the theory that the autonomic system operated independently of the central or axial system. This procedure amounts to a failure to consider the intimate interrelations between the two systems.

Axial and Autonomic Connections.—The most prominent mode of interconnection between the cranio-spinal and autonomic systems is by means of a system of fine branches known as rami

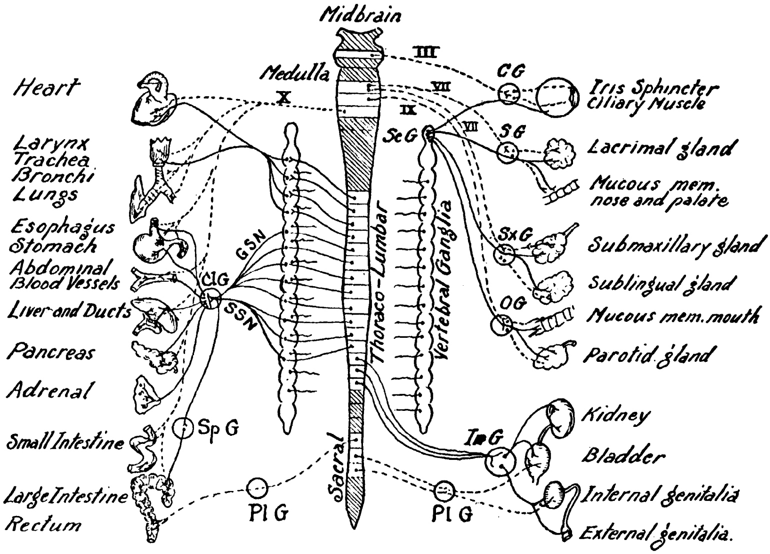


Fig. 95—Showing the interconnections of the autonomic nervous system. Broken lines indicate cranio-sacral or parasympathetic efferent connections. Solid lines indicate postganglionic fibers to spinal and cranial nerves to supply (1) vasomotors to head, trunk, and limbs, (2) motor fibers to smooth muscles of skin, and (3) fibers to sweat glands. CG, Ciliary ganglion; SG, Sphenopalatine ganglion; SxG, Submaxillary ganglion; OG, Otic ganglion; InG, Inferior mesenteric ganglion; SpG, Superior mesenteric ganglion; PlG, Pelvic ganglion; ScG, Superior cervical ganglion; ClG, Coeliac ganglion; GSN, Great splanchnic nerve; SSN, Small splanchnic nerve. Roman numerals refer to cranial nerves.

communicantes. These serve as connecting links between the spinal nerve conduction paths and the chain of vertebral sympathetic ganglia. The latter are illustrated in Figs. 94 and 95. There are two types of rami, the white and gray. The former consist of medullated fibers which conduct (1) efferent impulses from the ventral spinal roots over preganglionic fibers to sympathetic ganglia, and (2) visceral sensory impulses from the sympathetic ganglia to the cranio-spinal system. Gray rami conduct impulses from the

sympathetic ganglia over postganglionic fibers into the spinal nerves.

Not every spinal nerve connects with a white ramus. This connection is made only with the nerves of the thoracic and upper lumbar segments. The second, third, and fourth sacral nerves also connect with white rami; the fibers here do not run to the vertebral autonomic ganglia, but directly to the pelvic autonomic plexuses. Gray rami connect with every spinal nerve.

Taking the intimate interrelationship between the axial and autonomic systems for granted, we may now confine ourselves primarily to tracing out the efferent pathways which pass out of the axial system at four specific points. Impulses from the cranial autonomic division are conducted through (1) the midbrain by means of the third cranial nerve, (2) the medulla oblongata by means of the 7th, 9th, 10th, and 11th cranial nerves. The impulses from the spinal cord emerge from (1) the thoracic-lumbar and (2) from the sacral region (see Fig. 95).

(a) *The Cranial Division.* As we should expect from the enormous complexity of the visceral parts of the organism, the autonomic system is organized on different plans. As Fig. 95 indicates, the fibers from the cranial division consist of long preganglionic neurons which relay in local ganglia, such as the ciliary, sphenopalatine, and the otic, situated close to the organs with which they connect. Here a relay station is located where the impulses are discharged to short postganglionic neurons, which in turn discharge to the organs in the head and abdomen.

(b) *The Sympathetic Division.* The connections of the sympathetic branch are somewhat more complicated. The preganglionic fibers leave the spinal cord and enter a series of sympathetic ganglia lying in chains along the spinal column. Here they either relay, discharging their impulses across synapses which are made with fairly long postganglionic fibers, or else they pass through these ganglia and relay in more remote visceral ganglia lying at a long or short distance from the organs into which they finally discharge. Among these remote visceral ganglia are the celiac, the superior and inferior mesenteric, and the pelvic ganglia, all located in the abdominal cavity.

(c) *The Sacral Division.* The fibers of the sacral branch of the visceral autonomic system, like those of the cranial branch, consist of long preganglionic fibers which relay in local ganglia situated

close to the organs. The pelvic ganglion is an illustration. From this local ganglion short postganglionic fibers run to the bladder and colon. See Fig. 95.

(d) *The Enteric Division.* The enteric branch of the autonomic system is very different from the rest of the system. It consists of fibers which branch out into very complicated plexuses in the region of the alimentary canal, called the plexuses of Meissner and Auerbach. A number of these automatic plexus connections are shown in Fig. 94. These are very diffuse neural elements and are only very remotely connected with the central nervous system.

Double Visceral Innervation.—In most cases the various visceral organs are connected with the central nervous system by two means, one a sympathetic and the other a parasympathetic. Thus the stomach, kidney, liver, pancreas, and intestines are connected by means of the sympathetic through the celiac ganglion, and the parasympathetic through the vagus or tenth cranial nerve. On the other hand, the colon, rectum, and bladder are connected by means of the pelvic nerve from the sacral autonomic, and by fibers from the sympathetic which relay in the inferior mesenteric ganglia. In many cases the innervation by the two pairs is antagonistic.

According to Cannon, "the cranial supply to the eye contracts the pupil, the sympathetic dilates it; the cranial slows the heart, the sympathetic accelerates it; the sacral contracts the lower part of the large intestine, the sympathetic relaxes it; the sacral relaxes the exit from the bladder, the sympathetic contracts it"[5]

From a psychological standpoint the whole series of systems with their component organs and tissues all operate together in an unbroken unity as participants in behavior configurations. These behavior configurations constitute the reactional phases of stimulus-response interactions. Accordingly the psychologist looks upon the biological structures and their functions not so much as mere life-maintaining activities, but as factors in the complex behavior of human and infra-human animals.

The Psychological Implications of Nervous Action

A characteristic of the modern era of science is the attempt to connect the nervous system with psychological phenomena. The most generous interpretation of this fact is that it represents an

[5] Bodily Changes in Pain, Hunger, Fear, and Rage, p. 32.

effort to make psychological phenomena natural, or at least bring such phenomena into relation with natural events. It must not be overlooked, however, that the attempt to connect psychological happenings with the nervous system is inevitably dictated by the assumption that psychological phenomena are not themselves natural events.

Of especial interest to us now is the influence this essay has exerted upon our ideas concerning the nature both of the nervous system and psychological phenomena. So far as psychology is concerned this attempt at a connection has perpetuated the notion that psychological phenomena are functions of the nervous system and especially the brain. On the other hand, students of the nervous system have been induced to describe and interpret neural phenomena as the seat and locus of psychic processes or psychological functions. This has had anything but a salutary effect upon our ideas concerning the nervous system. We have already had occasion to refer to (1) the erroneous idea that neural impulses could not be measured (Chap. 22), (2) the inept tradition that the brain is the organ of mind (Chap. 23), and (3) the theory that learning means the connection of neurons (Chap. 16). Now we may consider two other conceptions closely related to the last.

The Nervous Level Theory

The eminent English neurologist, Hughlings Jackson, is credited with the suggestion that the nervous system operates in levels. The lowest of these is the reflex level, the highest the cortical, while between these two is an intermediate level. This conception was developed as an attempt to correlate neural functions with mental states, it being presumed that the cortex is concerned with all or most psychic happenings. Reflex actions were thus regarded as mainly neural actions of a lower level, and chronologically earlier in appearance. Despite the objectionable psychic implication, this conception is still a valuable pedagogical device in describing the workings of the nervous system. As a scientific description, however, it runs counter to the increasingly demonstrated fact that the nervous system operates as a totality, and more than this it operates invariably as one factor in a total behavior pattern.

Among the evidences against the division of the nervous system into localized functional areas may be mentioned first the work of

Sherrington, who proved that a very close integration exists between various parts of the organism.

Next we may refer to the work of Loeb and Child, who have demonstrated experimentally that the organism is a unit and that its activities develop as specialized actions out of mass or total action.

The details of such localizations of actions have been assiduously studied by biologists, especially Tracy, Swanson, and Coghill. Coghill states that in the animals with which he has worked (salamanders), reflexes develop as specializations of partial patterns out of total behavior patterns by individuation. Although Coghill appears to imply that the reflex later becomes a genuinely localized reaction and therefore a response of part of the organism, his work may definitely be interpreted as showing merely that directed actions of the organism develop later than total mass actions. Looked at in this way his work supports the organismic theory that the organism always operates as an indivisible unit.

Lashley and others have removed large portions (as much as 81%) of the hemispheres of animals and found them to be somewhat defective in their learning in proportion to the brain injury. These experiments appear to show, however, that even a badly injured animal operates as far as possible as an integrated organism. A similar implication is found in the clinical work of Dandy, who reports that the removal of the complete right hemisphere does not seriously interfere with complex, human, psychological activities.

But more important still is the fact that these experiments and clinical findings indicate that the brain no more than the spinal cord is a localized place for particular kinds of actions.

Localization of Brain Functions

The idea that different parts of the cortex are seats or loci of special psychological functions is another one of the peculiar implications arising from the theory that the nervous system is especially concerned with psychological phenomena. The crudest form of this is the phrenological conception that particular mental traits such as love, kindness, initiative, etc., have their special localizations in the brain.

Later this localization conception was refined and connected more closely with biological facts. It came to be held that seeing,

hearing, smelling, and tasting were located in particular places of the brain. What "functions" could not be thus accounted for were placed in "association centers." While this latter version has some biological justification, in the sense that the removal of, say, the visceral pathways would result in blindness, it is still not really supported by facts. The point is that the removal of such parts of an organism as contribute to a particular kind of reactional configuration will break up the configuration, but this is in no wise to say that a psychological function is located in a particular place in the brain or other part of the nervous system.

CHAPTER XXV

THE EVOLUTION AND DEVELOPMENT OF ORGANISMS

The Evolution of the Individual

Biologists still find great mysteries in the embryological process. How does the complex adult organism come into existence? There is, of course, the fact of cellular development. But how do the various developments come about?

Historically these problems have given rise to two opposing theories. The extreme preformationists believed that the animal was preformed in the egg. The adult organism came into existence without any real embroyological development because it already existed in the egg waiting to be unfolded.

Over against the preformationists stood the epigeneticists, who argued that the embryo began as a new thing altogether, a sort of creation unrelated to the older generation of animals.

It was Von Baer (1792-1876), a German biologist, who first discussed the problem in a convincing manner and has consequently been dubbed the founder of embryology. This investigator asserted that there was a genuine embryological evolution, in that the egg split up (cleavage) to form smaller units and that these developed into layers which gradually became differentiated into tissues and organs.

Today the conceptions of embryology follow those of Von Baer, with the addition that there has been a tremendous impetus given to the suggestion accredited to Roux that the whole development must be studied in terms of the interaction of the cell and its environmental conditions.

Stages in Embryological Development

SOMATOGENESIS.—Ontogenetic evolution or the development of the individual among vertebrate organisms begins with the fusion

of two cells, one each derived from the male (spermatozoon) and female (ovum) parents.

In organisms of both sexes the germ cells or gametes become separated off very easily from the general cellular material called somatic cells. The primordial germ cell which is regarded as the original germinal unit in each animal develops into a series of gametes through a process called gametogenesis. Gametes do not attain their maturity until the organism becomes sexually functional. At that time the ovaries of the female produce eggs (oogenesis)

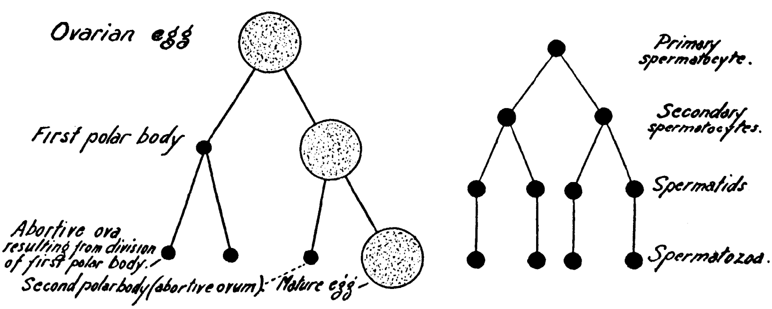


Fig. 96—Scheme to illustrate the maturation of ova and spermatozoa. Modified from Howell, after Boveri.

and the testes of the male generate spermatozoa (spermatogenesis). As in all cellular development the primary process consists of cell division.

Maturation.—Biologists agree that the phenomenon of reproduction is intimately tied up with the cellular elements of the nucleus called chromosomes.[1] In fact it is believed that the chromosomes are the specific cellular materials that pass on from each of the parental progenitors to form the individual of the new generation. This being the case it seems necessary, if the fused cell which is to develop into the new individual is to have both parents equally represented in it, that the two uniting cells must each lose half its chromosome material. This is the reduction phase of the general process of maturation.

Fig. 96 shows in diagram form how this takes place. Notice that both male and female cells undergo two divisions. Each time

[1] The name chromosomes is derived from the fact that these cell elements are susceptible to coloring by histological technique.

the female cell divides, one of the two oocytes called the polar bodies disappears from the process. In the case of the male cell the four spermatozoa formed after the second division are all functional.

Mitosis.—The process of maturation is a special case of cell division, for it results not only in the production of new cells but

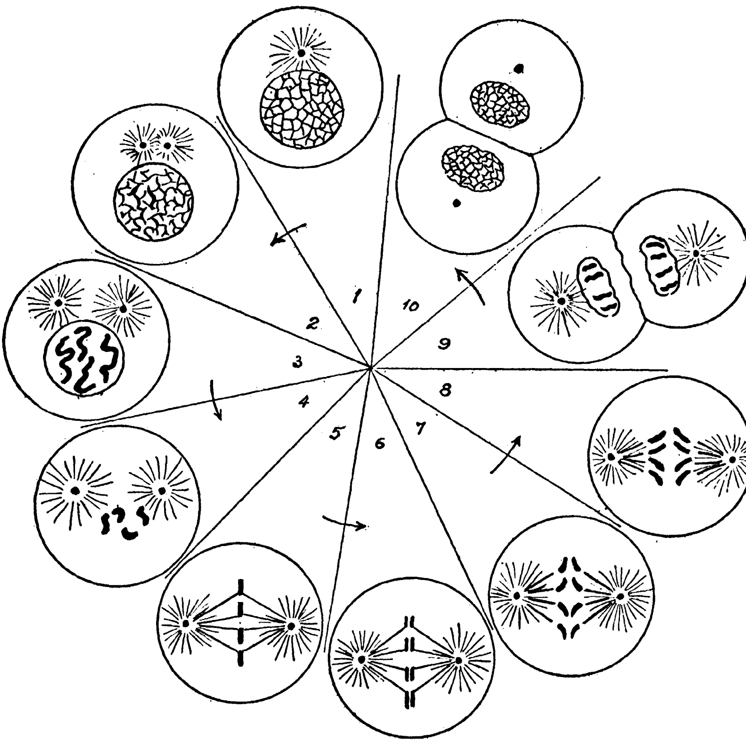


Fig. 97—Diagram illustrating mitosis or cell division. 1, resting phase, or beginning of development; 2, centrosomes divide, spireme formation begins; 3, chromosomes formed; 4, nuclear membrane disappears; 5, equatorial arrangement of chromosomes between astrospheres; 6, longitudinal division of chromosomes; 7, chromosomes migrating toward centrosomes; 8, beginning of cell division; 9, division of cytoplasm into two parts; each of two daughter cells has same number of chromosomes as parent cell but only half the amount of chromatin material; 10, chromosomes broken up into chromatin. Boveri drawings in circular arrangement suggested by Metcalf.

in their preparation for fertilization and reproduction. Mitosis or cell division is well illustrated in Fig. 97. Embryologists usually divide the mitotic process into five stages, which they name: (a)

resting (in diagram 1), (b), prophase (2-3), (c), metaphase (4-5), (d), anaphase (6-7-8), and (e), telophase (9-10).

Fertilization.—Fertilization takes place when the sperm cell finds its way to the egg, located in the Fallopian tube. The male cell in effect adds a second nucleus to the female cell. These are then called pronuclei because it is only after fusing that they be-

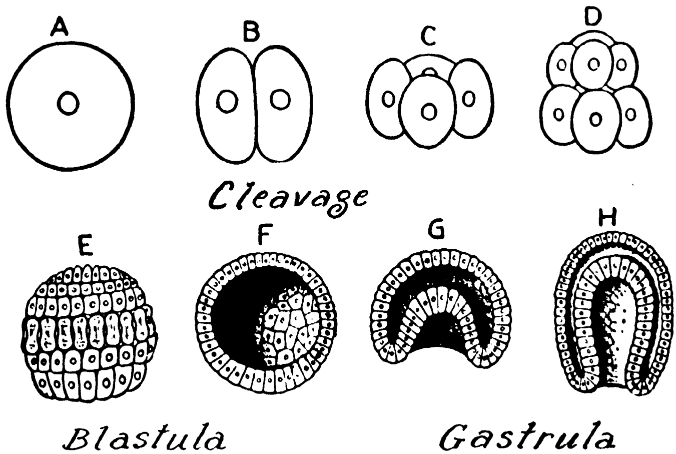


Fig. 98—Diagram of ontogenetic evolution. F, G, H, are sectioned to show interior. From Lull (after Hatschek and Wilder), *Organic Evolution,* by permission of The Macmillan Co., publishers.

come the real nucleus of the fertilized egg. This fusion is a necessary preliminary to the development of the new individual. The egg, after impregnation by the sperm, moves forward and becomes attached to the wall of the uterus.

Cleavage.—At once the cell becomes divided into two, four, eight, etc., units (Figs. 98, A, B, C, D), called blastomeres, without any appreciable change in the total weight of the initial cell.

The Blastula.—Next the blastomeres, which originally form an irregular solid mass called the blastula (Figs. 98, E, F), take on the shape of a hollow sphere when fluid collects in the interior. It is from the cells of the inner surface rather than from the outer more spherical cells that all the embryonic structures are developed.

The Gastrula.—During the development of the blastula occurs a differentiation of ectoderm and entoderm. The latter cells

enclose a cavity called the archenteron (primitive gut). This development in the lower forms (amphioxus), but not in the mammals, proceeds by the formation of a sort of double cup (Figs. 98, G, H). The cells forming the outer cup, facing the outside, are made up of the ectodermic cells, while the entodermic tissue lines the inside and surrounds the archenteron. This structure gradually develops into the digestive tract. The space between the two layers becomes very small and gradually is filled up with mesoderm cells, which are derived from the endodermal cells. The mesodermal cells line the coelom or secondary body-cavity. From the coelom are derived the major cavities—namely, the pericardial enclosing the heart, the peritoneal or abdominal, and the pleural or lung cavity, divided off from the abdominal cavity by the diaphragm.

ORGANOGENY.—The process of gastrulation marks the beginning of the growth of the organism and the development of particular organs.

The first of these to be observed are the neural organs. This tissue arises from the ectodermal cells on the dorsal side, which multiply rapidly, forming a thickened band called the neural plate. An invagination or groove is formed in this plate, and from this medullary groove is developed the neural tube, which becomes buried by an overgrowth of cells above it. From the ectoderm also originate the epidermis and the receptor organs.

The primary entodermal cells give rise to the notochord, which serves as the core around which mesenchymal cells from the mesoderm become arranged to form the vertebral column. These primary entodermal cells also give rise to the true entoderm, which develops into the digestive epithelium, the liver, pancreas, and the respiratory system.

After the mesoderm has evolved from the primary entoderm, two lines of development result. The first is the origin of mesenchyme cells which develop into the skeleton, in part the corium, and the circulatory system. The second results in the development of (a) the epimeres which give rise to the striated muscles and in part the corium; (b) the mesomeres out of which arises the execretory system; and (3) the hypomeres from which develop the peritoneum, the mesenteries, the unstriated muscle of the digestive tube, and the gonads. The accompanying schema illustrates the developmental process.

Progress in Embryological Development

- Sperm + Ovum
  - Fertilized Egg
    - Cleavage
      - Blastula
        - Gastrula
          - Primary Ectoderm
            - Epidermis, Central Nervous System, Sense Receptors
          - Primary Entoderm
            - Notochord
              - Chorda Dorsalis
            - Mesoderm
              - Epimeres
                - Striated Muscles, Corium (in part)
              - Mesomeres
                - Excretory System
              - Hypomeres
                - Peritoneum, Mesenteries, Non-Striated Muscles of Digestive Tube
              - Mesenchyme
                - Skeleton, Corium (in part), Circulatory System
            - True Entoderm
              - Digestive Epithelium, Liver and Pancreas, Respiratory System

ORGANISMIC MATURATION.—Physiologists estimate that about 280 days elapse from the time of conception to parturition or birth, although this time, as in all physiological processes, varies somewhat. The accompanying diagram (Fig. 99) indicates some of the size differences in the developing organism.

The Mechanism of Heredity

The life of organisms is cyclic. There are birth and death, growth and decay, besides a host of other minor periodic variations in structure and function. The process of reproduction is also one of these cyclic phenomena. In this case we have parts of organisms (the germ cells) serving as intermediaries between one adult generation and another, since the reproduction of vertebrates is always

bisexual. The progeny are derived from the intermediate stage representing the parents. The important problem biologists have to work out concerns the details of this cyclic procedure.

Fig. 99—The evolution of the human individual. First six stages from His, the other two from De Lee. Modified from Arey, *Developmental Anatomy*, Saunders, publishers.

Various Aspects of Heredity.—The interest in heredity is strongly linked with an interest in species formation or evolution. Here the fundamental question has been, how do the succeeding

generations or organisms become different? One answer has been that the slowly acquired characteristics have been transmitted to the offspring.

Darwin's Conception of Pangenesis.—Of historical interest is the pangenetic theory of Darwin (1809-1882) for the explanation of the transmission of acquired characteristics. Essentially this theory sets forth that all the cells in the parental organism give rise to gemmules, which are carried by the circulatory apparatus to the germinal cells. In consequence all the characteristic tissues with their accumulated variations can be represented in and transmitted by the reproductive cells.

The Theory of Germinal Continuity.—Weismann (1834-1914), a German biologist, elaborated the theory that organisms reproduce themselves by passing down to their offspring an actual part of themselves. Moreover, the germ plasm continues to exist through all the reproductive cycles in the various instances of the biological continuity of an animal species. The germ plasm he regarded as a distinct part of the organism, different and completely isolated from the rest of the cells.

Weismann's theory may be regarded as an answer to the followers of Lamarck (1744-1829), who believed that the organism transmits characteristics that it has acquired. Biologists object to such a strict notion of non-transmission of acquired characteristics, for how else than by changing and reproducing the changes can species develop? As it happens the Lamarckians and their opponents both are thinking in crude terms. The former think that immediate use changes an organism in a certain direction, and the latter merely think of mutilations as not being passed on.

The opponents of Weismannism also ask whether it is acceptable to believe that there is no continuity in the organism. Is it possible that no matter what happens to the individual there will be no physiological effect upon the germ cells?

An interesting experiment designed to throw light on this problem is that of Guyer and Smith. These investigators pulped up some rabbit's eyes in Ringer's solution and injected them into fowls. This developed an anti-lens anti-body in the fowl's blood. When serum from the fowls was injected into the circulatory system of a pregnant rabbit the mother was not affected, but 9 out of 61 progeny were born with defective eyes. The defects were observable in eight generations of offspring in both the male and female lines. It

is assumed that there has been a parallel induction of the effect in both the soma and germinal plasm. A number of later attempts to verify these results have failed and it is also rather certain that such eye defects occur often enough to cast doubt upon the above results.

THE CHROMOSOME THEORY.—Setting aside the problem of species change, the question arises, what is the exact mechanism of heredity? Many biologists agree that hereditary transmission is concerned with the chromosomes. Walter offers five supports for this theory.

In the first place, assuming that such unequally sized cells as the sperm and egg contribute equally to the transmissive function, it is the chromosomes that are primarily involved, for they can be equated.

In the second place, it is only the chromosomes which divide equally in the maturation process, thus allowing for the equal contribution to heredity of the two parent organisms.

Thirdly, it is believed that the abnormalities arising in progeny when one egg is fertilized by two or more sperm cells are due to the excessive male chromosome material.

Fourth, some biologists believe that there is a corresponding resemblance between the characteristics of chromosomes and the character of the progeny developing from the cells containing them. Walter quotes Tennent as saying that from a knowledge of the chromosomes in the parental germ-cells, particular characters in the adult hybrid may be predicted, and conversely, that from the appearance of sexually mature hybrids the character of certain chromosomes in their germ cells may be forecast.

And finally this author quotes some experiments of Boveri in which he shook out the nuclei including the chromosomes from the mature egg of a sea-urchin (Sphaerechinus) and then added to these enucleated eggs the sperm cells of another genus of sea urchin (Echinus). Although some animals resulting from this combination resembled the female species, most of them exhibited echinus characteristics.

THE GENE THEORY.—Students of genetics have gone much farther than the crude chromosome theory. They have attempted to account for the specific characteristics of organisms on the basis of particular determining elements. These are called genes. Morgan,

a famous American geneticist, developed the conception that the genes, which are presumed to be the factors determining the characteristics of offspring, are strung along the chromosomes like beads.

Geneticists regard the genes as determiners of unit characterters—that is, specific morphological traits of the individual. Some of these traits require more than one determiner, while some single determiner may affect more than one character. The latter conception is called the factorial hypothesis.

The conception of genes is a scientific formulation designed to account for facts observed in the breeding of organisms. Geneticists have therefore discussed different kinds of genes and different ways in which they produce their effects. These can be summed up as follows:

Single Gene Pairs.
- A. Alternative Conditions.
  - Allelomorphic.
  - Presence or Absence.

Several Gene Pairs.
- B. Cumulative effect.
- C. Modifying.
  - Complementary.
  - Supplementary.
  - Lethal.

Allelomorphs are genes which when present in the chromosomes give rise to alternative characteristics such as the yellow and green colors of peas. Other allelomorphs are tallness and dwarfness. Now in such a case the hereditary effect in the organism may be produced either by the dominance of one or the other determiner when they are both present, or by the absence of the other. The presence-absence theory is vigorously criticized by geneticists. When several pairs of genes are present the determiners may reinforce the effect which each would bring about separately. This is the cumulative effect of genes.

But the combination of genes may also serve to produce modifications in the organism's traits. An illustration is found in Bateson's experiment in which two strains of white sweet peas by self fertilization each held true to this color, but when crossed produced purple flowers. The genes involved are called complements because it is assumed that they are dissimilar in character.

Castle crossed a black guinea-pig with an albino and obtained an agouti or wild gray color. The black guinea-pig carried color, while the colorless guinea-pig carried a determiner for the pattern effect which gives the gray. The two genes supplement each other. The geneticists take this to illustrate a case in which the pattern gene modifies the determiner color, which exists and operates independently.

Lethal genes are those which operate to destroy a partial character of some sort or bring about the death of the individual in which they join forces. It is believed that lethal genes when operating separately, as when derived from only one parent, may not produce any ill effect.

THE CYTOPLASMIC THEORY.—Not all biologists agree that the chromosomes play an exclusive role as the "carriers of heredity." Some of them insist that the whole cell system including the cytoplasm is directly or indirectly involved in the production of every hereditary trait. There seems to be a gap between the static character of genes, which in consonance with the theory of germinal continuity remain always the same, and the ever increasing change and modifiability of the developing germ cell as it evolves into a complex individual. Also there is a wide gulf between the inevitable determining potencies of genes and the more or less indeterminate phenomena of the physiology of development.[2] Generally speaking, we must face here the problem of combining the continuity of the animal species, and the tremendously great variational possibilities of a specific individual.

THE TRAIT-STABILITY THEORY.—The heredity theories so far discussed are based upon an underlying conception that there is some sort of agency in the organism that keeps a line of individuals the same in general structure. This is a rather static viewpoint. Biologists, however, are beginning to veer far from such staticism and are coming more and more to consider the process of heredity as a dynamic phenomenon in line with the conception that all biological phenomena are exceedingly dynamic events.

The first implication of this dynamic viewpoint is that any process of transmission of traits must like all biological phenomena involve a mutual interaction of the organism and the environment.

[2] For an excellent discussion of this point, with further references, see Lillie, The gene and ontogenetic process, *Science,* 1927, 66, 361-368.

This means essentially that the biologist is taking account of a great number of specific conditions that are taking place, just as in the ordinary process of metabolism what we have is an inter-operation of cellular structures and chemical materials in which each of them undergoes many mutual changes. So in the case of the transmission of characteristics such a mutual interrelationship must occur. Heredity, then, is not the persistence of qualities which are passed down from generation to generation of organisms, but rather a process whereby organisms may or may not develop the biological qualities which their parents have had. In other words, if the parent organisms have passed through certain conditions and take on certain qualities as a result, the offspring will have the same history if the conditions are repeated.

In accordance with this dynamic view of biology there has arisen a conception, sponsored especially by Jennings, that an organism never transmits characteristics to offspring, but only a series of undifferentiated potentialities which will result in certain particular qualities on the basis of the organism's experiencing certain conditions.

The resemblance between offspring and parents may be regarded as a process of stabilization of qualities possessed by the parent organism, through the stabilizing influence of the environment. The latter term covers all the conditions and circumstances with which the new organism interacts throughout the process of germinal existence, fertilization, gestation, and post-natal maturation.

Four Methods of Studying Heredity

Biologists[3] utilize four general genetical methods in their study of heredity, two of which are statistical, and two more emphatically biological.

THE GALTON BIOMETRIC METHOD.—The first of the two statistical methods was inaugurated by Galton (1822-1911) and carried on by Pearson. The fundamental principle of the method is to measure resemblances between individuals in order to discover the contribution of each ancestor to the individual's hereditary make-up. While Galton seems to have realized that the heredity problem has two phases—namely, (1) the appreciation of likenesses between

[3] Cf. Pearl, R., Modes of Research in Genetics, Macmillan, 1915.

individuals, and (2) the causes of these resemblances, the biometric method in its greatest elaboration has to do only with the first. As Pearl points out, we can make the most minute correlations between two facts without knowing why such correlations occur. Again, as Pearl also indicates, in the biometric method there is a false assumption that heredity (in the static sense) is the sole cause (we might add any cause) of resemblance between parents and offspring.

THE MENDELIAN METHOD.—The second statistical method has been appropriately named after the justly celebrated Austrian monk Mendel (1822-1884) who experimented mainly on peas. The Mendelian method differs from Galton's in two ways. In the first place, instead of going back from the individual to its progenitors, it looks forward from parents to the progeny of organisms. Also instead of merely observing differences, the Mendelian method is experimental. Organisms are bred in order to discover the results.

Breeding experiments have yielded observations that have been made the basis for three Mendelian principles, the principle of segregation, independent assortment, and dominance.

A. The Principle of Segregation.—While working with peas, Mendel found that when he crossed a green pea-plant and a yellow one, the hybrid or first filial generation (F1) produced yellow seeds. The next generation (F2) produced three yellows to one green. The inbreeding of the green peas gave only green. One third of the yellow plants produced yellow peas exclusively just as in the case of the green, while the remainder acted like the F2 plants producing three yellow and one green. As we have seen, pairs of such characters are called allelomorphs and these segregate themselves; a gamete carries yellow or green genes but not both.

B. Principle of Dominance.—When the yellow and green carrying gametes unite, as in the example just given, it is found that yellow is dominant over green. In this case the green is called recessive. Green characteristics can therefore only manifest themselves when the dominant gene is absent and the recessive one is duplicated.

C. Principle of Independent Assortment.—Distinct characters operate as independent units.. Cross a plant that bears peas that are yellow in color and smooth in contour with one that bears green and wrinkled peas, and you find the F1 is smooth and yellow.

Yellowness and smoothness are dominant. When these peas are inbred, the characters will assort themselves in the following way. Nine will be yellow and smooth, three green smooth, three yellow wrinkled and one green wrinkled.

Linkage.—A very important exception to the principles of segregation and independent assortment is found in the phenomenon which the geneticists call sex linkage. Morgan and his co-workers have described the breeding conditions in which a red-eyed female of the fruit fly (Drosophila melanogaster) is bred with a white-eyed male resulting in the F1 generation of all red-eyed flies. In the inbred F2 generation, however, there were red-eyed females, both red and white-eyed males, but no white-eyed females. On the other hand, when a white-eyed female and a red-eyed male were crossed the F1 generation produced red-eyed females and white-eyed males. In the F2 generation of this cross, equal numbers of red and white-eyed males and females are produced. From these experiments geneticists have concluded that the determiner for red eyes is linked with the sex determiner.

Wieman[4] says these results can be explained upon the following assumptions: "(1) that red eye is dominant to white eye; (2) that the genes for both are located in the X chromosome; (3) that two X chromosomes produce a female, an X and Y a male; and (4) that the Y chromosome does not carry a gene for eye color."

Heredity and Sex

The phenomenon of sex provides a copious source of implications for inheritance as well as other types of biological theories. As a consequence students of biology have assiduously studied sex phenomena since the rediscovery and fostering of Mendelism.

One of the earliest conclusions was that sex in animals was one among many other biological characteristics whose existence was determined by a genetic factor. This theory was enforced by the cytologist's discovery that among many animals males and females possessed different complements of chromosomes. For example, among Drosophila the female was found to have two X and no Y chromosomes. It was thought then that sex was determined by this difference in chromosome material or by differences in the genes found in the differing chromosomes.

[4] General Zoology, McGraw-Hill, 1927, p. 237.

But these observations were soon supplemented by others which to a certain extent undermined their significance. Thus, for example, Bridges found among Drosophila, flies with two X chromosomes which were sex intergrades—that is, females resembling males more than females. It turned out that they had less X chromosome material in proportion to autosomes, or non-X or Y chromosome material. The conclusion was therefore reached that it is the ratio of the two forms of chromosome material that determines sex. A ratio of one X to 2 autosome sets gives males, while a 2:2 ratio results in a female organism.

What makes for these different ratios? It is suggested that they depend upon a metabolic condition. Now metabolic conditions are certainly not exclusively genetic in character. If sex depends somewhat upon metabolic conditions it cannot be entirely determined genetically. Furthermore, facts have been accumulating that lead toward the view that sex may be almost if not entirely metabolic in character.

Biologists have always known that secretions of the sexual glands give rise to so-called secondary sexual characteristics. In the human animal the hair distribution, voice, and general bodily contour constitute such sexual traits. A number of biologists, among them Riddle, Moore, Crew, Banta, etc., have performed gonad transplantation experiments and have reached the conclusion that to a certain extent at least metabolic conditions determine the sexual make-up of organisms. Other biologists, however, do not regard the transplantation experiments as fundamental, since the question still remains why any particular organism possesses either the male or female organs in the first place.

Sex alterations of a more fundamental type are suggested as evidence of the probable metabolic determination of sex. Here the work of Riddle on pigeons may be cited. He immediately removed the eggs laid by a pigeon with the result that the female was stimulated to lay a greater number of eggs than is ordinarily the case. As a consequence the female-producing eggs were greatly increased. This indicates that the ratio of the sex of the offspring is influenced by the metabolic condition of the parent animal. What is called the female-producing egg is one of two types laid by the pigeon. This type is larger than the other and also contains a greater amount of chemical potential energy. It must be added, too, that the two types differ in their chromosomal make-up.

Another type of evidence that appears to favor the metabolic theory of sex determination is the work of Richard Hertwig. This investigator delayed the fertilization of frogs' eggs in the uterus for three or four days. The result was that more males than females were produced, owing to a change in metabolic condition.

Pathological changes in the sexual organs of animals have been observed to transform completely the sexual character of animals. Riddle[5] reports the case of a female dove which laid eggs and in all respects functioned perfectly like a female organism. A few months after the last egg was laid the bird began to act like a male, taking on weight and developing the crow of the cock pigeon. Post mortem investigation of the animal's condition revealed the fact that tuberculosis had destroyed the female glands.

Another case reported by Crew[6] is that of a hen which laid eggs and reared chicks, then later fertilized eggs of a normal hen. This animal was later found to have tumor growths in the ovarian region.

Should this metabolic conception of sex determination be proved sound, the facts will have a tremendous bearing on our conceptions of the transmission of biological characteristics. Since sex as a biological characteristic operates very much as some of the other biological traits, and if it is determined by metabolic conditions instead of purely germinal factors, the interactional idea of heredity may receive considerable support. Riddle goes so far as to assert on the basis of his observation mentioned above that, "the result clearly indicates that the heredity basis of no bodily or mental characteristics may be considered as irrevocably fixed and uncontrollable."[7]

The Embryological Method.—The embryological method more than any other allows for the study of the interaction of the germ cells and surrounding conditions. By this method one can investigate what has been mentioned above as the physiology of development. Such investigation allows us to hope for the best results in discovering the detailed processes that give rise to particular kinds of structural development. The ascertainment of the exact relations between conditions in the gametes and their sur-

[5] See Science Service report, in *Science* for Jan. 4, 1924.

[6] Crew, F. A. E., Sex reversal in the fowl, *Proc. Royal Soc.*, 1923, B. 95; and *J. Heredity*, 1923, 14, 361-362.

[7] Quoted from *Science*, 1924, 1514, p. xii.

rounding media must throw considerable light upon the balance that exists between the determiners and the environmental conditions.

THE CYTOLOGICAL METHOD.—This is a distinctly biological method based upon observations of the germ cells. The cytological student of heredity attempts to discover the changes that take place in the cells when certain characters are transmitted. Studies of this sort have yielded information concerning the probable place of the chromosomes in the inheritance situation.

Psychological Heredity

What biological qualities are desirable for man? Is the shortness of Napoleon or the tallness of Lincoln to be preferred? There are probably no biological characteristics which can be determined upon as being the best for the human animal. We can, of course, value highly the qualities we prefer. But what of psychological characteristics? Here conditions are very different. All will agree that there are psychological qualities which are not only absolutely desirable, but also equally indispensable. Among these are high intelligence, keen reasoning, subtle and refined feeling, etc. There are many who believe that such psychological characteristics are inherited. Were this the case obviously they should be selected for transmission.

But can psychological traits be inherited? To believe so involves great difficulties. It is fitting here to quote the words of Morgan, who, as one of our foremost students of genetics, might be biased in favor of psychological transmission. He says,[8] "A comparison of the facts of Mendelian heredity relating to plants and animals with what is known of human heredity leaves no doubt, as far as physical characters are involved, that the same rules apply to both. The extraordinary physical resemblance of identical twins to each other establishes on the soundest basis the fact that heredity plays an all-important role in the inheritance of structural characters. But it is extremely hazardous to carry over this inheritance to the psychic character of man where there is no certainty as to what extent his behavior is determined by heredity and by environment. Until suitable methods have been applied

[8] The Mechanism and the Laws of Heredity, in The Foundations of Experimental Psychology, 1929, pp. 1-36.

that are discriminative, conclusions will be largely a question of personal opinion or conviction."

As was pointed out in Chap. 4, the psychologist raises several difficult questions concerning psychological heredity. In the first place, he asks whether psychological phenomena are characteristics of the sort that the biologist knows to be transmissible; in short are psychological traits structural characteristics? Psychological phenomena are beyond question ways of acting. Here a second question is in order: Are psychological phenomena the functions of particular biological structures as are physiological actions? If not, where is the transmissive effect?

The Theory of Evolution

The cornerstone of all biology is the theory of evolution. It is this theory which provides a basis for all biological facts and principles, and gives meaning to organic phenomena. The evolution of the animal series can be fairly well correlated with the different geological periods of the earth's history. (See chart, p. 442.) Biologists offer various kinds of evidences for their belief in evolution.

PALEONTOLOGY.—Fossil remains of plants and animals argue for a continuity of development in organic forms. Despite the gaps it is possible to piece together the development of (a) the more complex from the simpler animals throughout the whole range of organisms, and (b) the continuous evolution of a single type of animal.

Everyone is familiar with the expression "from ameba to man." While this is, strictly speaking, merely an expression, it does symbolize what is undoubtedly an upward evolution in complexity and intricate organization.

So far as single types of animals are concerned, the science of paleontology shows what are practically perfect evolutionary records. An instance is the evolution of the horse. Marsh (1831-1899), an American paleontologist, collected one of the first classical fossil records of this animal.

The horse is traced back to a small animal about the size of a fox or dog with four complete and one rudimentary toe on the fore feet and three toes on the hind feet. It is estimated that this animal lived about 3,000,000 years ago. As Lull[9] points out, the

[9] Organic Evolution, Macmillan, 1925.

Geological and Biological Evolution

Geological Age	Animal Age	Geological Period	First Evidences of Animal Types
Cenozoic	Age of Mammals	Quaternary: Recent or Human Pleistocene or Glacial	
		Tertiary: Pliocene Miocene Oligocene Eocene	Man Higher Mammals
Mezozoic	Age of Reptiles	Cretaceous (Upper Cretaceous) Comanchean (Shastian, Lower Cretaceous) Jurassic Triassic	Small Reptiles Mammals Birds, Great Reptiles (Dinosaurs, etc.)
Paleozoic	Age of Achrogens Amphibians	Permian Pennsylvanian (Carboniferous, Upper Carbonif. Coal Measures) Mississippian (Subcarboniferous, Lower Carbonif.)	Primitive Reptiles Amphibians
	Age of Fishes	Devonian	Complex Fishes
	Age of Invertebrates	Silurian (Upper Silurian) Ordovician (Lower Silurian)	Insects Fishes
		Cambrian	Crustaceans Molluscs Protozoans
Proterozoic (Algonkian)			Beginning of Animal Records
Archaeozoic (Archaen)			No Animal Records

direction of horse evolution is toward swifter locomotion and more effective food-getting traits, both of these intimately interrelated with increase in size.

The horse series, of which some of the members have been named Epihippus, Mesohippus, Protohippus, to Equus, show a gradual development in size, teeth formation, and the loss of toes resulting in a single-toed hoof.[10]

Paleontologists possess numerous evolutionary series similar to this one. A partial record of this sort is indicated for the human animal in Chap. 24.

Comparative Anatomy.—The comparative study of what appear to be widely differing forms shows relationships which can only be intelligently explained on the basis of organic evolution. For example, a definite plan seems to run through a whole series of organisms. Despite the differences in vertebrates based upon different modes of living, there are all sorts of homologies and analogies. Homologous organs like the wings of a bird and the arms of man correspond in structure, but not in function. The eyes of various organisms are alike in function, but not in structure. The eyes of squids, insects, and of men are thus analogous, but not homologous. The arms of monkeys and of men are both homologous and analogous.

Embryology.—It is a striking observation that the embryos of higher animals resemble the developing organisms of simpler types. For example, the circulatory system of the embryonic mammals resembles that of fishes. The presence of gill slits in the embryos of human, bird, and reptile animals likewise indicates an ascent or descent from the fish form. The hair and tail of the human embryo are also reminiscent of earlier stages of evolution. Such facts undoubtedly point to the development of one type of animal from the other.

Vestigial Organs.—Various animals have useless organs as parts of their make-up which can only be accounted for on the basis of having passed through a different kind of organization. Homologous forms of such organs are functional in other species. The famous German anatomist Wiedersheim[11] has recorded almost

[10] See Osborn, Origin and History of the Horse, 1905.

[11] Cf. Wiedersheim, The Structure of Man, Macmillan (Eng. trans. 1895).

two hundred vestigial and retrogressive organs in the human organism.

An instructive example of vestigial organs is the presence of check valves in the rib-veins and their absence from the back-veins in the human organism, as pointed out recently by Stiles.[12] Such valves in the rib-veins are not needed since they are situated in a horizontal position, though they could serve as checks on the back pressure of the blood in the vertical dorsal vein. It seems that when the human animal evolved his upright posture, these structural features of his make-up, which were only useful in his prone postural ancestors, did not disappear. Man still carries them with him as vestiges.

How Species Arise

The records of human thought indicate that theories of evolution have always been entertained by thinkers.[13] The fundamental problem in the study of evolution becomes therefore the precise mechanisms by which species become modified. There have been numerous suggestions.

Direct Action of the Environment.—According to this view the external conditions of animals and plants bring about modifications in the organisms, which are transmitted and perpetuated by heredity. Buffon (1707-1788), the French naturalist writer, is especially identified with this view. Lamarck also held this conception as far as plants are concerned, but at the same time he believed that animals were a little more indirectly influenced. He held that the environment operates primarily upon the nervous system and indirectly upon the morphology of the organism.

The detailed method of species change, Lamarck ascribed to the principles of use and disuse and the need of the organism. The long neck of the giraffe was acquired by reaching for leaves on branches. By spreading the toes upon striking the water, aquatic birds have developed their webbed feet. Cave and underground-dwelling animals (moles, cave fish) in the same manner have lost their eyes.

Natural Selection.—The doctrine of natural selection is essentially the application by Darwin of Malthus' population principle to species variation. Species change through the process of nature's

12 See *Science*, 1926, 1627, p. xiv.

13 See Osborn, From the Greeks to Darwin, Columbia Press, 1894.

selection of the variations that are necessary or useful for survival. Malthus popularized the conception of the tendency of organisms to reproduce in greater numbers than there are food supplies. Darwin assumes then that a great struggle for existence is a fundamental fact of organic life. Now some animals happen to possess morphological features that fit them for survival. These are selected by nature.

Like most theorists about evolution, Darwin did not hold to one single thesis. In addition to natural selection he believed in sexual selection. According to this view certain characteristics of animals became established in species because they were preferred by the animals of the opposite sex and thus were transmitted to future generations. This type of theory is now completely rejected by biologists.

Darwin changed his views concerning the origin of variations. At one time he merely assumed that variations occurred and were then transmitted, but later he was much inclined toward the Lamarckian idea of use and disuse.

Mutation Theory.—In agreement with other thinkers Darwin regarded most variations as falling into a normal range. These he called fluctuating variations, but there was another type which he thought of as abnormal and not of frequent occurrence, called sports. About 1900 the Dutch botanist, De Vries, presented and defended a theory that species variations always come about by the persistence of mutations. From some unknown causes operating upon the germ-plasm of the organism such mutations arise. Species change then through sudden alterations rather than the slow accumulation of variations. Though mutations come about through changes in germ-plasm, De Vries believed that they were perpetuated through natural selection.

Orthogenetic Evolution.—Biologists who observe the apparently continuous development of biological characteristics in lines of animals have developed the view that there are forces either in organisms or their environments and sometimes in both that condition their evolution in a straight line.

Among the views stressed by the proponents of orthogenesis are (a) germinal continuity as over against sudden mutations or changes, and fortuitous variations, and (b) the impossibility of

permanent changes in the organism brought about by use and disuse.

The Adaptation of the Organism to its Surroundings

With keen insight biologists have recently defined organisms as bundles of adaptations. This means that they increasingly recognize that organisms cannot be regarded as isolated phenomena. An organism is only one phase of a dynamic unity, the other being the things and conditions with which it is in constant interaction.

This is not a new idea, for we find that Spencer[14] at the very dawn of scientific biology wrote of life as a continuous adjustment of internal to external relations. But in recent decades the specific facts illustrating that life is largely a relation or adjustment between the properties of the organism and those of the environment[15] have come to the front. That the characteristics and changes of the organism correspond to characteristics and changes of the environment has been excellently stated by Child,[16] as follows:

"A living organism is a specific complex of dynamic changes occurring in a specific colloid substratum which is itself a product of such changes and which influences their course and character and is altered by them."

No observation is more common than that the very existence of an organism depends upon the tolerant or intolerant conditions surrounding it. Who is unfamiliar with the timber line, and with the facts concerning necessary and optimum conditions for growing plants and animals? In this connection, too, we are all acquainted with the striking phenomenon of mimicry or protective coloration as well as with various other devices adapting organisms to their particular surroundings.

Adaptation or ecological phenomena are therefore obviously just as intrinsic and important facts of biology as the facts of morphology or physiology. Indeed, to the student of psychology ecological phenomena may be a trifle more important. For the biological interactions between the total organism and its surroundings may be regarded as a bridge between psychological and bio-

14 Principles of Biology, Appleton, (4), 1888.

15 Brooks, W. K., Foundations of Zoology, Macmillan, 1899.

16 Senescence and Rejuvenescence, Univ. of Chicago Press, 1915, p. 26.

logical phenomena in a way that the intraorganic interactions are not.

In order to present ecological phenomena briefly, we may arbitrarily divide them into three compartments: (a) the organic phases, including all the conditions and activities of organisms which parallel various changes in environmental conditions; (b) the essentially environmental factors—namely, the things and conditions which influence the organism's actions and morphological changes; and finally (c) some instances in which organic and environmental conditions and actions are equally involved. In this last phase organisms are the environmental factors.

Organic Phases of Ecology

EXISTENCE.—The very fact of an organism's continued existence constitutes a primary ecological adaptation. Contrariwise, the organism that fails to adapt itself must disappear. The existential form of biological adaptation may be studied in two ways. In the first place, the problem that every organism has to continue its existence and maintain a modicum of well-being can be directly observed in health and medical records. In the human organism, of course, such adaptations must be made not only to natural environments, but to social and economic conditions also.

In the second place, the paleontological records of the successive ages of animals and plants undoubtedly constitute an historical register of organic adaptation. On the other hand, these records also demonstrate the passing out of existence of plant and animal organisms because it was impossible for them to keep up with changes in environment.

DISTRIBUTION.—Cacti grow in deserts; black men come from Africa. These are instances of the distribution of organic forms. This does not always mean that particular organisms can only thrive where they live, but the fact that there are optimum environments as well as absolute limits for the maintenance of life amply manifests some of the effects that habitats have upon organisms. Here the reader may be reminded that some biologists go so far as to make geographical isolation a primary factor in the evolution of animal forms.

STRUCTURE AND FUNCTION MODIFICATIONS.—The European male bullfinch fed on hempseed loses its bright red color and be-

comes reddish brown like his mate. Biologists report numerous structural changes in size, depending upon food. In Morgan's work on fruit flies it was found that the black bands of the fly's abdomen were broken up into irregular spots or were entirely absent when they were fed upon moist food. In this same work it was observed also that lower temperatures produced supernumerary legs.

In addition to food and temperature there are other environmental conditions which completely modify organisms. Changes in mode of life produce great variations in parasitic organisms. Complex animals lose their digestive apparatus and become different kinds of organisms. Locomotor organs are replaced by organs for attachment and adhesion.

Growth and Development.—It is known that the growth and development of fertilized eggs are greatly influenced by environmental conditions, such as the kind of nutriment they receive, as well as by temperature and other circumstances. We have already suggested above that it is probably adaptations to environment at this period of ontogenetic development that compete seriously with genetic factors as determiners of what the adult individual's development will be like. The factors operating to condition the biological character of the organism are potent not only during the uterine life, but all through the period of post-natal growth and development.

Behavior Characteristics.—When an orb-spider is disturbed it will quickly spin a long thread by means of which it drops to the ground. Various beetles also perform such defensive behavior. The deceptive acting opossum offers another familiar instance. These activities represent adaptations to particular forms of environmental conditions. Other instances of such adaptive behavior are the feigned lameness of the partridge, and the hibernation of such different animals as bears and reptiles. In Chap. 4 we have had occasion to point out that it is probably such adaptive behavior which is the basis of what are wrongly called instinctive actions among animals.

Environmental Factors of Ecology

Biotic Environment.—Every organism constantly interacts with the flora and fauna of the district in which it is found. Organisms feed upon other organisms, and consequently a large part

of their lives consists of struggles to overcome or escape being overcome. One of the best indications of the nature and extent of the biotic environment is found in the facts of biological balance. Huxley's statement of the balance on the basis of which England is able to maintain her position as "mistress of the seas" has become classic. It runs as follows. To be capable of commanding the seas Englishmen must be strong, to be strong they must eat good beef, to have good beef the cattle must have good clover, the amount of clover depends upon the existence of bumble-bees to fertilize plants, how many bees there are is contingent upon the number of mice which might destroy their combs and nests, the number of mice is determined by the number of cats, and since these are conventionally maintained by maiden ladies, the number of spinsters is responsible for England's supremacy.

ANTHROPOEIC ENVIRONMENT.—The human animal is a special kind of biotic environmental influence. Because of his complex organization and activities he has been responsible for all kinds of biological adaptations. He has cultivated organisms, distributed plants and animals, and exterminated others. Besides such direct operations upon biological beings he has brought about many changes in environmental conditions by drying marshes, flooding territory, and otherwise benefitting or harming organisms.

CHEMICAL AND MECHANICAL ENVIRONMENT.—A specific place must be given to the chemical surroundings of organisms. The kinds of gases, water, and salts in soil and food materials exert an exceedingly important influence upon the characteristics and behavior of plants and animals. Similar interactional influences are found in the mechanical agencies of nature, such as atmospheric pressure.

LIGHT ENVIRONMENT.—Phototropic or heliotropic actions suggest light as a special condition for many and varied adaptations. Biologists are probably just beginning to understand the importance of various kinds of light, such as ultra-violet rays, in the life of organisms.

PHYSIOGRAPHIC ENVIRONMENT.—The contour of the environment, whether marsh, lowland, or hilly country exerts a tremendous influence on the morphology and physiology of organisms. It is

hardly necessary to point out the great importance of streams, lakes and sea coasts upon the human individual and human society.

Climatic Environment.—Climatic conditions are of two general sorts. First, there are the fairly constant temperature, rainfall, and other meteorological ranges. Temperature, for example, affects pigmentation and coloration as well as the intensity or activity of plants and animals. Then there are the highly variable changes in climate such as wind, rain, and snow storms.

Mutual Phases of Ecology

Association of Colonies.—The intimate living together of ants, wasps, and bee colonies constitutes adaptations in which organisms are joined together in interdependent units for interaction with environing circumstances. At the same time they are also environments for each other. The former situation is illustrated by the bee colony of queen, workers, and drones, or an ant colony consisting of queen, drones, and maxim, minim, and medium soldiers and workers. Here complete organisms become morphologically and physiologically specialized in order to divide biological responsibility, in the same manner in which the various cells and tissues are organized in a single animal. Since the minims are so closely interconnected with food production and provision, they are from the standpoint of the other ants hardly distinguishable from the environmental fungi which they tend.

Commensalism.—The living together of morphologically unrelated forms is a striking instance of organism and environment interaction. When zebra, ostriches, and gnu are associated, or when the remora or suckfish attaches itself to sharks and other fish, each animal becomes environment for the other. An interesting example of commensalism is that obtaining between the hermit crab and the sea anemone. The latter feeds on the food that the crab gathers and leaves, while it conceals the crab from its enemies and also protects the crab by its stinging cells.

Symbiosis.—Among the most intimate forms of organic interrelationship is that of lichens, an association consisting of fungi and algae. A typical form of symbiosis is the mutual benefit derived from each other by bacteria and their hosts. The bacteria secure food and shelter from the hosts, while the latter derive aid in digestion and food assimilation.

PARASITISM.—When the host derives positive harm or at least no benefit from its guest, the association is called parasitism. When the tape worm invades the human or other animal digestive tract, or when bacteria break down tissues for their own exclusive good, we have a parasitic form of ecological adaptation and lack of adaptation.

IMMUNOLOGY.—Immunology, the science which is concerned with the adaptations of organisms to their parasitic invaders, has significantly enlarged our knowledge of biological interaction. When Koch (1843-1910), a German bacteriologist, about fifty years ago first began to study bacteria as disease-causing agencies, the idea prevailed that the host was a passive environment that merely provided a field for the operation of the bacteria. As a result of this conception it was believed that pathologists need only study bacteria or protozoa by themselves in order to discover their disease-causing characteristics. This viewpoint leads to the invalid assumption that bacteria can just as well be studied in the test-tube as in the living host.

More recently bacteriologists and pathologists have come to the conclusion that parasitic invasions and bacterial infections are fundamentally interactional phenomena. As Smith has pointed out, the damage that a parasite can do to a host depends upon the host.[17] The invaded organism must be regarded not as a static organization of biological or biochemical materials; rather, the specific results of invasion or infection depend upon both the type of invading organism and the character of the tissue, the body fluids, and the different stages of the organism's development—in short, upon both the parasite and host, and the specific conditions of their interaction.[18] The facts of parasite adaptation constitute a transition to the general consideration of pathological conditions of organisms.

Pathological Conditions of the Organism

As a final item in our brief summary of the outstanding facts of biology we shall consider the disturbing conditions in the life and action of living things. In view of the fact that there are

17 Smith, Parasitism as a factor in disease, *Science,* 1921, 54, 99-108.

18 See Manwaring, Post-Ehrlic immunology, *Science,* 1931, 74, 324-327; and Curphey and Baruch, The need for a new experimental approach in immunology, *Science,* 1932, 75, 79-80.

always individual differences in the organization and operation of organisms the question arises when a certain condition may be regarded as a disturbance. Generally speaking, the criterion for pathology is extreme variation in any of the biological characteristics or functions. A secondary criterion may be regarded as any condition interfering with the well-being of any particular organism —that is, with the ordinary course of its organic existence.

It is a serious problem how to organize the facts of pathology. One might emphasize the thing that serves to bring about the pathological condition or one might stress the results to the individual. For our purposes it will suffice to consider changes in the organism with respect to the items of morphology, physiology, development, and ecology.

MORPHOLOGICAL DISTURBANCES.—Morphological aberrations include injuries or lesions of whatever sort that make the individual different. The loss of an eye or an arm, no matter how brought about, constitutes such a pathological condition. Wounds and lacerations of all sorts, scalds, and burns must also be added.

PHYSIOLOGICAL DISTURBANCES.—The general metabolism of the individual can be subjected to more or less extreme variation. When this is the case, the general physiological conditions of the individual are regarded as pathological. This sort of pathology can be induced by extreme changes in temperature, anesthetic drugs, lack of nutritious food, improper food, and ingestion of toxins. Among the diseases here may also be mentioned autointoxications and fevers. Disturbing factors can, however, be localized in the function of particular organs. Among the more localized pathologies are anemia (circulatory dysfunction), diabetes (glandular disharmony), and gastritis (unusual stomach conditions). Another form of localizable pathology is found in the respiratory diseases brought about by irritants like coal or stone dust.

DEVELOPMENTAL DISTURBANCES.—A series of striking abnormalities of development result in various sorts of monsters like Siamese twins. These are the most unusual as well as the most unique forms of developmental pathology. Other abnormal conditions associated with glandular disturbances are known as giantism and dwarfism. Rickets is a disease of bone development. The baffling and still unconquered cancer is also a pathological development localizable in particular tissues.

Ecological Disturbances.—Invasions by other organisms such as bacteria and protozoa suggest themselves at once as the primary ecological pathology. All of these can be generally subsumed under the heading of infections. Among the specific diseases that may be mentioned here are amebic dysentery and sleeping sickness, induced by protozoa, while blood poisoning, typhoid fever, cholera, scarlet fever, tetanus, anthrax, diphtheria, and syphilis are failures of adaptation to bacteria. Among the ecological disturbances induced by larger parasitic organisms are hookworm and tapeworm diseases.

CHAPTER XXVI

MAN AS A BIOLOGICAL ORGANISM

Anthropology: Organic and Cultural

It seems only natural that the human animal should be intensely interested in his own species. To such an interest no doubt we may ascribe the origin of anthropology, the science of man. But the greatest impetus to the study of man was provided by the Darwinian doctrine of the close relationship of all animals.

The science of anthropology lends itself to a convenient division. On the one hand, when we study man as an animal, we investigate such questions as (a) the period of his probable appearance on the earth with respect to geological age, (b) the various factors in which men vary, and (c) the relationship between the different types of human beings. This is organic, or as it is sometimes called, physical anthropology. The second division of anthropology is concerned with the civilizational or cultural aspects of man. By civilization or culture is meant the mode of life of human beings, including the objects, techniques, and organizations found in all groups. Among the problems here are (a) the origin and evolution of particular groups or societies, (b) the organization of the personnel of various groups, (c) the varying equipments of such groups with respect to tools, weapons, customs, ideas, beliefs, and other phases of culture or civilization, and (d) the interrelationships between particular individuals and their societies.

The Evolution of Man

The evidences concerning man's evolution make it clear that man has not evolved from any form of sub-human animal now extant. Rather, man and his anthropoid cousins have all descended from a common stock that has given rise to both forms of animal life.

Naturally the fossil records of man's development are very sketchy, but nevertheless they tell an interesting if incomplete story.

PITHECANTHROPUS ERECTUS.—In 1891 Dubois, a Dutch scientist, found near Trinil, in Java, a skull-cap or calvarium, and a molar tooth. Later a left thigh bone, two other teeth, and a fragment of a lower jaw were unearthed in the same place. From these remains information has been pieced together concerning an animal that is neither man nor ape, but closely related to both. The skull, which indicates a narrow receding forehead and heavy projecting supraorbital ridges, is estimated to have a cranial capacity

Fig. 100—Reconstruction of Pithecanthropus. From Quennell, *Old Stone Age*, courtesy of G. P. Putnam's Sons, publishers.

of about 900 cubic centimeters. The largest living ape has a skull capacity of about 600 cc. The thigh bone suggests that the animal was upright in posture and stood about 5 feet 7 inches in height. A reconstruction of the appearance of this type is indicated in Fig. 100.

SINANTHROPUS PEKINENSIS.—Asia, which is expected to produce many evidences of human evolution, up to recent times has disappointed archeologists. In 1929 and 1930, however, some important findings were unearthed at Chou Kou Tien about 40 miles from Peking, or Peiping, as that city is now called. Up to 1929, when W. C. Pei, a Chinese geologist, found an almost complete brain case, only a few lower jaws, some teeth, and skull fragments had been discovered. But now students are convinced that there

is sufficient evidence that a new type of man has been revealed. In addition to the skull of what was apparently a young woman, found in 1929, an adult male skull was unearthed the next year.

Professor Davidson Black, who studied the 1929 and earlier findings, is of the opinion that the Chinese dwellers of a period variously estimated to have been 400,000 to 1,000,000 years ago represented an evolutionary development between the Pithecanthropus and Neanderthal man, but much closer to the latter. Other authorities do not agree, but believe rather that those prehistoric Chinese were not so high in the human scale.

Fig. 101—Reconstruction of Eoanthropus dawsoni. From Quennell, courtesy of G. P. Putnam's Sons, publishers.

HOMO HEIDELBERGENSIS.—The earliest authentic human fossil consists of a lower jaw discovered by Schoentensack in 1907 in a gravel pit near Heidelberg, Germany. This fossil was found at a depth of about 80 feet together with animal remains, as often happens with human fossils. The jaw is heavy, massive, and chinless, but the teeth, though large, are human since they are set close together and have dilated crowns. This animal lived probably only half as long ago as the organism called Pithecanthropus.

EOANTHROPUS DAWSONI.—At Piltdown Common, near Sussex, England, an amateur archaeologist by the name of Dawson, in company with Dr. Woodward of the British Museum, uncovered during 1911-13 what appear to be the skull fragments of a woman. The lower jaw indicates that this animal was more like an ape than authentic man, but the brain case is pronounced to be like that

of the modern human animal. Authorities found it difficult to determine where this type of man belongs in the evolutionary scale. Woodward placed him high in the human ladder. Hooten believes Eoanthropus to be more like the ancestor of modern Europeans than any prototype yet found. Keith, who at one time thought he was a primitive offshoot from a human stock, which developed human characteristics in a period preceding the ice age, now shares the view of Woodward and Hooten. The anatomist's conception of this type is indicated in Fig. 101.

Fig. 102—Reconstruction of Neanderthal man. From Quennell, courtesy of G. P. Putnam's Sons, publishers.

HOMO NEANDERTHALENSIS.—Neanderthal man has left many fossil records. Instead of a few fragments there are at least six nearly complete skulls and several whole skeletons. The first of these was discovered in 1856 near Düsseldorf, Germany. Neanderthal man was primitive but human. He was short in stature, comparing with the modern Japanese. The cranial capacity was large, about equal to that of the modern European. This primitive man was apparently slouchy in his posture, and bow-legged, but possessed a powerful physique. How this man looked is suggested in Fig. 102.

HOMO SAPIENS.—From the year 1868 are dated the first findings of fossil remains of what are probably ancestors of the Caucasian type of modern man. The Cro-magnon race of people were tall and well developed biologically, and indicate a high degree of

civilizational capacity. There is evidence that the cranial capacity of the Cro-magnon was greater than that of modern man. (See Fig. 103.) The Cro-magnon group seems to have covered a period of 15,000 years. It is important to note that the fossils of what are apparently the later types of individuals are smaller than the earlier and come closer to modern man.

Two skeletons of what might have been a woman and her son were found at Grimaldi near Mentone, France, in 1906. The measurements of the remains indicate that the Grimaldi people

Fig. 103—Reconstruction of Cro-magnon man. From Quennell, courtesy of G. P. Putnam's Sons, publishers.

were negroid in form. The jaws were prognathous, the nose flat, and the eye orbits narrow, the skull capacity 1,375 and 1,600 cc., respectively, although the male was not fully grown. The Grimaldi individuals are regarded as different from all other people.

It is hardly necessary to remind the reader that this brief summary of the findings of human fossils does not afford us a unified record of evolution. There is certainly no complete chain of connected links. Some scholars are of the opinion that there is not even a suggestion of a prehistoric Mongolian man. And yet it is sufficient to suggest the gradual development of the human type of organism. It must not be overlooked either that the study of human evolution has just begun. The progress that is being made

can be indicated by the record of Keith's publications. In 1915 this scholar summed up the available materials in a volume entitled *The Antiquity of Man,* which by 1925 grew into a two volume treatise. A revision was then called for in 1929. This year (1931) Keith published a sizable volume entitled *New Discoveries Relating to the Antiquity of Man.* In this last book the student will find valuable discussions of the most recent discoveries of human remains in East and South Africa, Australia, Palestine, and various parts of Europe.

The Cradle of Mankind

Where on the earth's surface did man originate? Or did he evolve at various points? In the absence of any definite evidence concerning happenings which took place so long ago there is naturally no decisive answer to such questions. Paleontologists generally incline toward the assumption that man originated at some particular spot and then migrated to all the various places where he is now found.

There are many speculations concerning this cradle of man. Some scholars believe the precise spot lies somewhere in Europe; others just as firmly favor Asia, while still others insist upon some place in Africa.

Asia is proposed because of its central location and because it offers favorable routes for migration. Then, too, the size of this land with its variety of climates and other conditions commends itself to the proponents of the Asiatic origin of mankind. And finally, Asia appears to be the home of most domesticated animals and of some of the oldest civilizations.

If the presence of remains argues for the origin of man at a certain place, Europe is entitled to a great many votes, since paleontologists find there remains of a number of man's anthropoid relatives. Most of the archeological remnants of primordial civilizations are recovered from European territory. Europe, too, was the home of Piltdown, Heidelberg, and Neanderthal man.

Africa is making increasingly greater claims to the distinction of being the original home of man. From that continent come Rhodesian, Boskop, and other ancient men. Africa has also produced the earliest fossil monkey known and the first anthropoid ape. Then, too, Africa is the home of many great ancient civilizations.

It is no small still voice that proclaims that all of these efforts to locate the cradle of civilization at some particular place are completely misplaced. For example, Hooten asks why it is not possible that the evolution of man has taken place in various parts of the earth. Keith also accepts this view of the situation.

When Did Man Originate?

How old is man? Nobody knows. But there are many hypotheses and assumptions. According to some authorities man has existed upon the earth for a million years or longer. Other students of paleontology do not place the figure so high.

Geological time is divided into five great eras, the archaeozoic, proterozoic, paleozoic, mesozoic, and cenozoic. Since geological time-scales are based upon fossil remains found in different strata of the earth's crust, the eras are divided into periods according to animal findings. Thus, as the chart on page 442 indicates, the Cambrian, Ordovician, and Silurian periods of the Paleozoic are the ages of invertebrates; the Devonian of the same period, the age of fishes, and the Carboniferous and Permian, the age of amphibians. For the same reason the Mesozoic era is regarded as the age of reptiles, and the Cenozoic, the age of mammals.

Because of the interest in the human mammal type the Cenozoic period is divided into two subdivisions, the Tertiary and the Quaternary. It is presumed that man probably evolved in the Pliocene or last period of the Tertiary or in the Pleistocene or first period of the Quaternary. The Quaternary or the Age of Man is further subdivided into the Pleistocene, the evolutional stage of man, and the Recent period, man as he exists today.

Man's appearance on earth is a very recent event as the age of the earth goes. For if we date the beginning of man's evolution as a matter of a paltry million years it counts for little as against the billions of years of the age of the earth.[1] The age of man even counts for only a fifth of the total age of mammals which is estimated to have covered a period of 5,000,000 years. Von

[1] There are various ways of determining the age of the earth. For example, one basis is the thickness of the various rock strata whose rate of decomposition is estimated. Another is the amount of salt in the sea. But the most modern and best way is based on the transformation of atoms, and especially the transformation of uranium to form lead. This gives a result of about 3,000 million years.

Hevesey[2] offers the following interesting comparisons: "If the age of a human being is one second, of the human race six hours, then the lower limit of the age of the earth is one year, and the age of the stars is 5,000 years."

Comparative Morphology

Like all animals the human organism displays an infinite variety. These individual differences apply to height, shape, color, and all sorts of proportions. One individual is tall and slender, another short and slender, while others are made up on the basis of a different combination. The same thing is true for various interrelationships of other anatomical qualities. The tall individual may be dark or light in complexion, while the short individual may vary in the same general way. Anthropologists have attempted to discover anatomical trends among the populations of the earth as a basis for classifying groups of people. The following are some of the prominent morphological measures.

Cephalic Index.—The ratio of the maximum breadth and length of the head according to the formula:

$$\frac{B \times 100}{L}$$

is called the cephalic index. The way this anthropometric measure is made is indicated by Figs. 104 and 105. The maximum length is measured by a compass spread from the Glabella (a slight swelling between the eyebrows above the root of the nose) to the Inion (the rearmost point of the skull). The maximum breadth is obtained by spreading the compass from the Asterion (where the squamo-parietal and squamo-occipital sutures meet) on one side to the same point on the other. This index varies with age, sex, and group. An index below 75 is counted as doliocephalic or long headed; from 75-80 mesocephalic or medium headed; above 80 brachycephalic or broad headed. Kroeber points out that since the average index for mankind is 79 it would be better to use indices of 81 and 77 instead of 80 and 75. It must be noticed also that the living head measurements are usually two points higher than that on the skull.

[2] The age of the earth, *Science*, 1930, 72, 509-515.

Mean Altitudinal Index.—The formula here is:

$$\frac{H \times 100}{\text{Mean of } L + B}$$

The height of the skull is measured by a line which reaches from the Basion (the median point on the anterior margin of the foramen magnum) to the Bregma (the median point of the coronal sutures). As the formula indicates, this magnitude times 100 is divided by the average of the length and breadth of the skull.

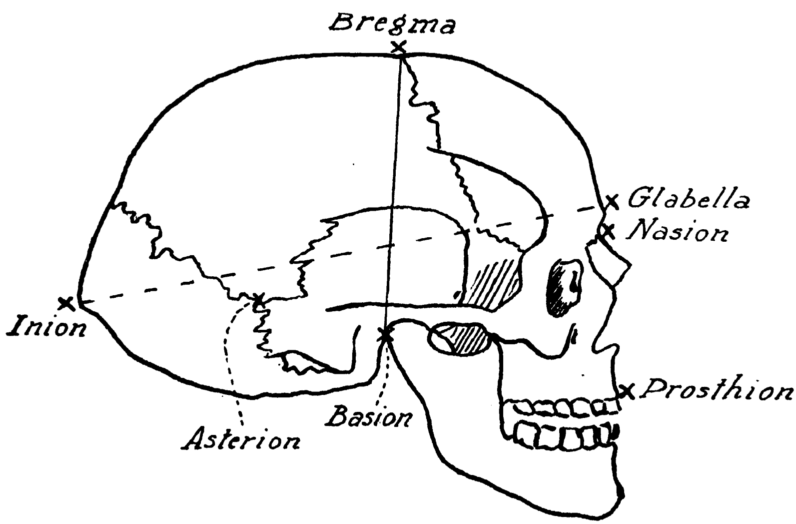


Fig. 104—Skull indicating landmarks for measurements.

Cranial Capacity.—Students of anthropometry regard the measurement of cranial capacity as of great importance, because of the underlying assumption that the size of the brain is a most significant feature of the human organism. The fundamental technique here is to fill the calvarium or brain case with some kind of rounded seed or shot and then to measure the amount of substance required.

Anatomists believe that a cranial capacity of 900 cc. differentiates man from his anthropoid cousins. The average capacity for the human male is given as from 1450 to 1600 cc. and for the female from 10 to 12 percent less. Among some groups the range given

reaches down to 1250 cc. Skull capacity correlates with anatomical size and varies to the extent of more than one-third in different individuals of the same group.

Stature.—Although the average variations in height are confined within the limits of about 12 inches, stature variations are among the most striking of individual differences. The general human average is given as 5.5 or 5.6 inches. The normal variations of groups range from 5 ft. to 5 ft. 10 inches. Among abnormal

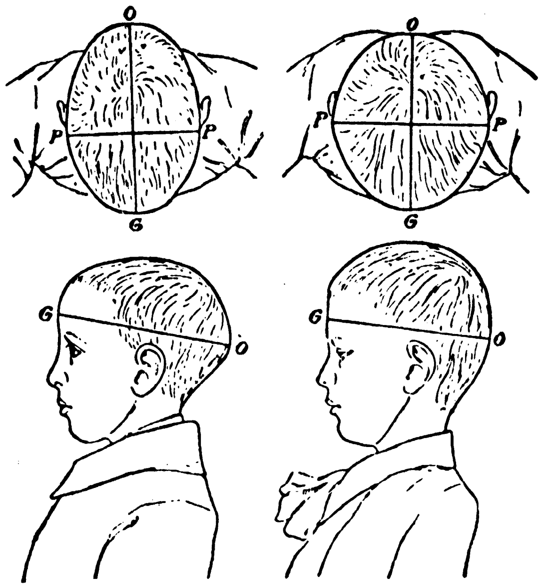


Fig. 105—Dolicocephalic and brachycephalic skulls. First boy: length of head 190 mm., width of head 137 mm., cranial index 72.1. Second boy: length of head 174 mm., width of head 154 mm., cranial index 88.5. G-O=greatest length of head, P-P=greatest width of head. From Baur, Fischer, and Lenz (after Rose), *Human Heredity,* by permission of The Macmillan Co., publishers.

variations are such "giants" as Charles Byrne, who is said to have been 8 ft. 2 in. in height, and Cornelius MacGrath, who was 7 ft. 8 in. tall. At the other extreme are the dwarfs, who range from 2 to 4 ft.

Anomalies in stature suggest problems concerning the conditions correlated with such height differences. Giantism and dwarfism can satisfactorily be connected with glandular insufficiency or hyperfunctioning. Cretins can be improved by thyroid extract feeding.

Giantism is likewise associated with hyperfunctioning of the pituitary gland. It is known, too, how greatly undernourishment affects growth, as well as differences in occupation, social class, and hygienic conditions. On the other hand, it is reported that many groups of very tall people live under conditions of food scarcity and undernourishment.

Jaw Protrusion.—The strong man in popular estimation has a prominent or projecting jaw, while the jaw of the weakling recedes. The anthropologist, on the other hand, associates the prognathic or projecting jaw with simian characteristics. Although jaw protrusion is difficult to measure on the skull, the anthropometrist has developed the alveolar or gnathic index to cover such differences, indicated in the formula:

$$\frac{\text{Basion to Prosthion} \times 100}{\text{Basion to Nasion}}$$

When the result is below 98 the jaw is called orthognathus; between 98 and 103 it is mesognathus, and above 193 prognathus.

Nasal Index.—In many ways the differences in size, shape, and prominence of nose are the most striking of the many facial characteristics. In general, noses differ in height of. bridge, in length, width, and prominence of wings and openings or septa, and in shape (aquiline, pug, Grecian, etc.). The nasal index used by anthropometrists is given in the formula:

$$\frac{\text{Width} \times 100}{\text{Height}}$$

When measured on the skull the index below 48 is called leptorrhine, between 48 and 53 mesorrhine, and above 53 platyrrhine. For the living nose the figures are 70 and 85.

Hairiness.—One of the great differences found in comparing men and women is the amount of hairiness on the body. But the differences here are approximated when persons of the same sex are put side by side. Some men and women are almost hairless by comparison with others of the same sex. These variations are superficially emphasized, of course, by hair color. A black-haired person may be mistakenly regarded as more hairy than a light-

haired person. Hairiness is generally correlated with other anatomical characteristics. Thus Caucasoid peoples are more hairy than Mongoloid or Negroid peoples.

HAIR TEXTURE.—The marked differences of hair texture can be observed in different skin areas of the same individuals. The gamut of hair texture on a single person runs from a fine down to coarse strings or curly threads. These variations are exaggerated between different individuals. A familiar contrast is the coarse beard of one man and the downy suggestion of hair on another. The hair texture seems to depend upon the diameter of the hair as well as upon the straightness or curvature of the root sacks in the skin. The general character of the skin and the underlying tissues probably exerts its influence also. No doubt the most striking hair differences are found in comparing the wooly hair of the Negroid head, the straight hair of the Mongoloid, and the wavy head covering of the Caucasoid peoples.

FINGER PRINTS.—Criminologists and police officials rate the differences in skin patterns on the finger tips as the most characteristic of anatomical traits. This view is no doubt entirely justified by its practical usefulness in the detection of criminals. Similar prints of other members are being developed.

BLOOD AGGLUTINATION.—The type of blood is an interesting and practically important individual difference, though limited to only four groups. When a person loses blood by being wounded or lacks a sufficient amount because of some disease it is necessary for another person to provide a supply. But this transfusion process may be fatal unless the two individuals have the same type of blood.

Type of blood is determined according to whether it will agglutinate or clot when mixed with the serum of other blood. This reaction depends upon the presence in the erythrocytes or red blood cells of substances called isoagglutinogens. These are of two types. Whichever type is found in a particular person's blood is not affected by the agglutinins of that person's blood serum. But the agglutinins of one person's serum may agglutinate the blood of another person whose blood contains different kinds of agglutinogens.

Landsteiner, who discovered this fact, presents the following table[3] to show the different groups:

Serum of group	Agglutinins in serum	Erythrocytes of group			
		O	A	B	AB
O	$\alpha\beta$	—	+	+	+
A	β	—	—	+	+
B	α	—	+	—	+
AB	—	—	—	—	—

The striking differences in blood can be seen from the table. For example, serum of blood O will agglutinate all cells but its own, and its own cells will not be agglutinated by any serum. Serum of AB, on the other hand, will not agglutinate any cells, but its cells will be agglutinated by serums from all blood classes but its own.

Other Differences.—Among the many other individual differences we need only mention the size and shape of ears, hands and feet, teeth formation, and character of eye. Differences in the type of eyes are especially marked. Probably the most familiar variation here is that between the Mongoloid or slit eye, which is due to the folding or overhanging of the upper eyelid, and the non-Mongoloid eye, which does not show this slit form. Between these two extreme eye forms are several intermediate varieties, some showing a slight fold on the nasal or temporal side of the eyelid.

Comparative Physiology

Just as individuals differ in size and color, so they vary in their physiological functions. Indeed, morphological and physiological phenomena are merely phases, one of the other. We know that the character of the stomach depends upon its digestive functions, while, on the other hand, the capacity to digest depends upon the morphological character of the digestive organs.

Moreover, since physiological characteristics emphasize the work or operation of the organism we should expect the individual differences to be more marked. Structural organization at any

[3] Individual differences in human blood, *Science*, 1931, 73, 403-409.

given moment is relatively fixed, while the physiological actions of the individual are more subject to the influences of immediate conditions.

How long does gestation last? When does puberty begin? What is the interval of human fertility? The answer to these as to every other physiological question is that it depends upon the individual. Biological phenomena are extremely variable. This means that the numerous conditions which go to make up the processes are combined differently for each person.

The individual physiological differences include variable blood pressure, pulse rate, basal metabolism, depth and rate of respiration, glandular secretion, muscle tonus, etc. In all these functions the normal for one person may be very different from that of another.

A striking difference for groups of people is reported by Hrdlicka. He found that the pulse rate for Southwestern Indians and Mexicans averaged about ten beats less than is the case among whites. Similar variations are found in respiration, temperature, and metabolism. The latter type of function is especially important as showing the connection between physiological and morphological traits. What is known as bodily constitution is probably a matter of metabolic rate. For example, the linear and lateral types of Stockard, the asthenic, pyknic, and athletic types of Kretschmer, doubtless illustrate such physiological differences.

Rate of metabolism is probably closely connected with the secretory processes of the glands, and especially those of the thyroid. It is well known, too, that the different secretory functions of the male and female organisms are responsible for the beard of the former and its normal absence in the latter.

Comparative Pathology

Differences in abnormal or pathological conditions are just as prominent as normal individual differences. Individuals vary in their degrees of immunity and susceptibility to various diseases. Of the various persons under the same living conditions some will develop tuberculosis while others will not. The same thing is true for cancer, asthma, and other diseases. It is obvious that the mere presence of pathogenic bacteria in a district does not mean that all persons will be equally affected. Of a given number of exposed

persons only some individuals will contract the diseases in which such pathogenic agents operate. Epidemics never involve whole populations, but only certain persons.

To account for such differences we must consider the development of constitutional conditions from before birth and on, as well as the general condition of the various interrelated structures and functions of the individuals concerned. A child that has suffered from rickets is much more susceptible to bronchitis and pneumonia than one who has not passed through this malnutritional condition.

Then there is the question of home surroundings, which in one case make for hygienic conditions and in another for disease and distress. The proper care of children, the exigencies of rural or urban life are responsible for great differences in the health and disease of individuals. These conditions are factors in the type of individual the adult becomes.

Classification of Human Organisms

Although every human being is different from every other the differences run to extremes. It is impossible to disregard the great gulf that divides the white man from the black as far as skin color is concerned. Furthermore it happens that the segregation of individuals into groups or peoples frequently consists of a division of people along cleavage lines made up of such extremes. Hence the idea of races.

Students of humanity have occupied themselves assiduously with the problem of classifying human beings into groups or races on the basis of the variations which we have enumerated.

The first systematic classification is that of Carl von Linné (1707-1778), frequently referred to as Linnaeus. This scientist was primarily a botanist, but also a great general taxonomist. In his great work *Systema Naturae,* first published in 1835, he classified human beings into six varieties, on the basis primarily of color and distribution, as follows:

Homo sapiens
  Var. Americanus rufus
  " Europeus albus
  " Asiaticus luridus
  " Afer niger
  " Ferus
  " Monstrosus

The next to the last class includes various peculiarities and abnormalities, and the last what he regards as unique groups, for example the Patagonians. Although Linnaeus is criticized for emphasizing location it turns out that as a matter of fact that characterisic is quite a rational classificatory feature. The greatest mistake, however, of this classification was that Linnaeus correlated color and habitat with temperament and other traits which are not subject to differentiation along racial lines.

The next prominent classification is that of Blumenbach (1752-1840), a German anthropologist. He omitted the last two fanciful classes of Linnaeus and added a fifth type—namely, the Malay in order to take account of the Oceanic people. His classification, published in 1776, is based upon various characteristics and employs the following categories.

I. Caucasians,	Europeans (excluding Lapps and Finns).
	West Asiatics.
	North Africans.
II. Mongolian,	Asiatics, Finns, Lapps, Greenlanders, Eskimos.
III. Malayan,	South Sea Islanders.
	Malakkans.
	Filipinos.
IV. Ethiopians,	Africans.
V. Americans,	American Indians.

Of the many other classifications, that of Deniker (1852-1918), the French anthropologist, may be mentioned. This scholar denies altogether the concept of race in the human animal. He classifies people, however, on the basis primarily of hair texture and secondarily on the basis of location. This gives six grand divisions, 17 subdivisions, and 29 or 30 specialized groups. The large divisions run as follows:

A. Hair woolly, with broad nose.
- I. Bushmen
- II. Negroid

B. Hair curly to wavy.
- III. Ethiopian
- IV. Australian
- V. Dravidian
- VI. Assyroid

C. Hair wavy.
- VII. Indo-Afghan
- VIII. North American
- IX. Melanochroid

D. Hair wavy to straight, with light eyes.
 X. Xanthochroid
E. Hair wavy to straight, with dark eyes.
 XI. Ainu
 XII. Oceanian
F. Hair straight.
 XIII. American
 XIV. Eskimo
 XV. Lapp
 XVI. Eurasian
 XVII. Mongol

One of the most recent and instructive classifications is that of Hooten,[4] which may be abbreviated as follows:

A. White Group ("European," "Eur-African," "Caucasoid")
- *a. Races*
  1. Alpine (Czechs, many Bavarians, and Southern Slavs, Russians)
  2. Armenoid (most Armenians, Turks, Syrians, etc.)
  3. Nordic (Upland Swedes and Norwegians, North Germans, English, etc.)
  4. Mediterranean (Egyptians, Arabs, Spanish, Portuguese, etc.)
  5. Ainu (Mongoloid admixture)
- *b. Sub-races*
  1. Dinaric (Albanians, Croats, Montenegrins, etc.)
  2. East Baltic (Finns, Russians, Esthonians, etc.)
  3. Arab (North African Arabs, Spanish and Mediterranean Jews)
  4. Berber (most Moroccan and Algerian Berbers)
  5. Keltic (Southern Irish and Scotch Highlanders)
  6. British Bronze Age or Beaker (common in Ulster and North Germany)

B. Negroid Group
- *a. Races*
  1. Negro (Tshi, Ewe, Ibo-speaking groups)
  2. Melanesian (Melanesians, Papuans)
  3. Negrito (Pygmy, Wambuti of Ituri Forest, Semang of Malay peninsula)
- *b. Sub-races*
  1. Nilotic (Dinka, Shilluk, Lango, etc.)
  2. Tasmanian (Tasmanians extinct in 1879)

C. Mongoloid Group
- *a. Races*
  1. Mongol (Mongols, Buriats, Kalmucks)

4 Quoted from Up from the Ape, 1931, with the courtesy of The Macmillan Co.

D. Composite Group

a. Races

1. Bushman-Hottentot (Bushmen and Hottentots)
2. Dravidian (Tamils, Telegus, Todas, etc.)
3. Indonesian-Malay (East Indian Archipelago)

b. Sub-races

1. Indonesian (Muruts of Borneo)
2. Malay (Malays of Malay Archipelago)
3. Polynesian (Samoans, Tahitians)
4. American (a race of several elements, Mongoloid most important)

c. American Sub-races

1. Palaeo-American (known from skeletal remains—South America)
2. Brachycephalic Mongoloid (Pueblo Indians, Apaches, etc.)
3. Tall dolichocephals (New England Indians, Iroquois, etc.)
4. Eskimo (Greenland and Labrador Eskimo)

Although in the long history of class making, human beings have been divided and subdivided on various bases, until a maximum of 63 races has been obtained, the tendency today is to use only a threefold classification—namely, the Caucasoid, Mongoloid, and Negroid.

Are There Different Races or Species?

The history of the theory of organic evolution offers us a striking example of intellectual adaptation. When the conception that man was descended from the lower animals was first proposed it was fought tooth and nail because it seemed to degrade man. But it soon became evident that it was wiser to adapt oneself to such a factually entrenched theory than to try to annihilate it.

This adaptation was soon made and in a very interesting way. Instead of allowing the evolutionary theory to debase man, some persons began to make use of it to foster their perennial desire to aggrandize themselves. If we must accept the idea, they seemed to reason, that man has descended from a lower kind of animal, why not make use of this conception to indicate that some of us stand higher on an evolutionary scale than others? Thus white people attempted to establish their superiority by claiming that they represented higher stages of evolution than the black or yellow peoples.

It is an interesting question how far the theory of evolution can be used as such an argumentative weapon. Even if it could be so employed would it give the white man the advantage? For we

must not forget that although other types of men than the white are not so familiar with the evolutionary doctrine they too regard themselves as superior. For example, although we call certain of the natives of South Africa, Hottentots, after the Dutch who thus baptized them, they call themselves "Khoi-Khoin," that is to say, "Men of Men." Even the Bushmen who are today primitive hunters living under the most abject of human conditions call themselves Kwai (Men) to distinguish themselves from other inferior mortals.[5]

We would believe in a caricature of evolution were we to assume that evolution has stopped operating. No doubt the human species is now evolving as rapidly as it ever did, but what evidence is there that some of us are more highly evolved than others?

It is a favorite sport of the partisans of racial superiority to point to the negro's protruding jaw, his broad and low nose, and receding forehead in order to prove that he is more ape-like in appearance than his white brother. But unfortunately for them the white man is much more ape-like in his hairiness than his black or yellow kinsmen. In hair texture and hair length also the black is farther from the ape than either the yellow or the white man, who stands next to him. The color and width of his lips likewise put the black man farther away from his anthropoid cousins than his white or yellow relatives.

We may therefore raise the question whether there is any such thing as a race at all in a biological sense. That is to say, are there distinct groups of human beings with distinctive sets of biological characteristics? If the white man is different from the black man in color, he has the same stature. And let us not forget that the white man or Caucasoid is not always white. It is well known that the Hindu students in America do not wear their tarbushes merely to show that despite their European clothes they are still different people, but rather to protect themselves against the indignities which they are made to suffer because Americans regard them as negroes. There is a further point. Even if it is true as some believe that the Mongoloid, Caucasoid, and Negroid peoples have evolved at different places on the earth and perhaps at different times, there is now a hopeless mixture of men. Recall that man has always been a migrating animal, and that centuries before so many

[5] See Havemeyer, Ethnology, Ginn, 1929.

black people were brought to the Western continent there were numerous intermixtures of the Mongoloids of Asia, the Negroids of Africa, and the Caucasoids of Europe. If this is the case for the large human groups that are justifiably regarded as different people, how much truer it must be for the different sub-groups under the large divisions.

Race conceptions are probably the offspring of national superiority complexes. From the earliest dawn of history we have records that even within the three large human divisions, groups of people have regarded themselves as fundamentally different in human quality from their neighbors. Historically the Greeks regarded other people as barbarians, while the Hebrews thought only of themselves as the chosen people. It is no doubt the same human circumstances that have given rise to the present dogma of Nordic superiority.

Although anthropologists attempt to divide off human groups on the basis of the average differences between groups of peoples, since these differences will not hold for every individual we must conclude that, after all, the criteria for classifying human groups are really based upon non-biological characteristics. Some of these criteria are geographical; others are civilizational. This applies to the larger groupings. The smaller groups represent linguistic (Latin, Teutonic people), religious (Hebrews, Mohammedans), political (Anglo-Saxon, etc.), and, of course, combinations of these civilizational characteristics.

Human Classes and Psychological Behavior

The student of psychology cannot help but inquire concerning the bearing of the race problem upon psychological questions. If there are no races can there be group differences in psychological capacity or performance? It is generally believed that there are different psychological capacities not only for the three grand divisions of men, but also for different nations or ethnic groups. Psychological science does not support such a view. Aside from the fact that it is impossible to find clear cut races as biological entities, there are other considerations that nullify such a doctrine.

Let us consider first the question of capacity. Can psychological capacity, whatever that may be, be correlated with biological characteristics? Suppose for a moment that there are races, in other

words, groups of peoples with permanently unique and distinct biological traits. Could we then suppose these people to be endowed with unique psychological capacities? As we have seen (Chap. 3), though biological characteristics and conditions (injuries, sickness, etc.) do influence psychological development, since they operate as limitations and possibilities, they do not function as bases for specific kinds of psychological capacities and conduct.

Consider, too, that capacity never means anything except in terms of accomplishment or performance. And of course individuals do differ in all sorts of performances; some are greatly superior to others. But here all the findings appear to show that the most biologically diverse individuals—those, namely, who vary extremely in sex, color, size, and shape—perform equally complex and equally superior activities.

But we must not overlook, of course, the great variations of performance of individuals when confined to certain groups. No Papuan has ever invented a revolver or a gas balloon, to say nothing of a machine gun or an airplane. Here is the field of group psychology.

Sex differences between individuals are probably the most diverse of biological traits. Yet psychological science shows no definite evidence that these differences are correlated with fundamental psychological characteristics. Again, the work of Woodworth, Rivers, Meyers, and Thurnwald, who had opportunities to test such comparatively simple activities as sensory discrimination in so-called primitive peoples, failed to show any significant variation in psychological traits. The same results are obtained from the so-called intelligence tests. Individuals and the groups to which they belong are divided off from each other only insofar as their reactions are influenced by civilizational conditions.

Since only such persons as Langley and the Wright brothers have invented airplanes, for instance, we may justly conclude that the psychological capacity and performance of individuals in a group depend upon given conditions. Thus the civilization of a group influences and sets limits to the psychological character of its members. As long as the members of a group belong to and remain integral parts of that collectivity they are psychologically what the culture of the group permits them to be and nothing else, unless, indeed, they have contacts with other groups.

This does not mean, of course, that persons do not achieve things as individuals. They do. It is doubtless true that all novelty and change among groups are the work of persons. The point is, however, that such achievements are interrelated throughout with group conditions.

CHAPTER XXVII

MAN AS A CULTURAL ORGANISM

The Cultural Unity of Man

What is the difference between a Frenchman and a Hottentot? It is an interesting experiment to try this question on various individuals. After the first surprise has given way to sober reflection the answer is frequently forthcoming that you just cannot make any comparison. The Frenchman, of course, is civilized, while the Hottentot is a savage. Now just what is the difference between a civilized man and a savage? The answer, obviously, depends upon what we mean by these terms.

What is civilization? The anthropologist has a ready answer. There are certain phenomena, to wit, language, industry, social organization, and so forth, which if found in a group make it a civilized one, while their absence signifies a lack of civilization. Since no student of human phenomena has ever found uncivilized people it appears improper to call some civilized and others uncivilized or savage.

The question of the difference between a Frenchman and a Hottentot really amounts to an inquiry concerning how the Hottentot group differs from a French one with respect to the details of social organization, technology, religion, and so forth. No doubt the civilization of the Frenchman is very much more complex, but there is no evidence that it is absolutely different in kind from that of the Hottentot. By calling the latter a savage, therefore, one probably merely refers to the fact that Hottentot civilization is relatively more simple than that of European groups.

When we take into account the actual conditions of men on different parts of the earth we find they differ only as the details of their civilizations vary. All men are civilized. To study the differences between men is merely to work out the cultural variations of their groups. In this sense every man participates in a civilizational unity.

Social Organization.—All human individuals are organized into families, clans, tribes, nations, and confederations. So inevitable is organization in the lives of men that social scientists have frequently asserted that human societies are organisms. As in the organism each part is inevitably and functionally related to every other part, so in the same way persons have their places and duties in the body politic—in other words, in society. First we mention political organization with its rulers, leaders, and followers. Then there is vocational organization with its analogy to the physiological division of labor. Here the various members of a group are divided into fishermen, hunters, priests, preparers of food, soldiers, etc.

Marriage organization with its specification of the family type is always a central feature of every society. In one group there is one husband to one wife (monogamy); in another, one husband with more than one wife (polygyny); and in still another, one wife with more than one husband (polyandry). Each of these marriage systems brings with it different forms of relations between children and parents, and also differences in kinship terms.

In European societies the social and economic strata resulting in the classification of nobles or upper classes, middle classes, and proletarians suggest the organizational phenomena of castes and ranks of persons and families. Everyone is familiar with the division of Roman society into patricians and plebians. All human groups are organized into numerous associations based upon wealth, family descent, bravery, sex, and various other real or imaginary qualities.

Technology.—There is no human group which does not make use of various technical processes for carrying on the life activities of the community. In a simple society, fire is made by rubbing sticks together, whereas we strike matches manufactured in a factory with elaborate machinery. Technology may be of the simple hand type or of the complex machine form which produces things impossible in any other way, but no group lacks industrial processes. Every group manufactures and uses tools for making fishing tackle, agricultural implements, weapons of offense and defense, household utensils, clothing, houses, as well as boats, wagons, and other transportational objects.

Art.—It is a significant fact that the records concerning the earliest dawn of human life consist to a great extent of art objects.

Among these are the drawings and sculptures of the prehistoric cave dwellers. Among living groups there are no people so humble but that they have a more or less highly developed appreciation of art. The simplest art development takes the form of decorations on tools and household utensils. So-called primitive people decorate their pottery and weave patterns into their baskets and blankets. Even the simplest civilizations of Africa reveal sculptures and carvings which bespeak a high level of artistic creation.

RELIGION.—Despite the great difficulty in defining religion we find certain prominent features in the thoughts, beliefs, and practices of men of all times and places which must somehow fall under this category. No doubt this fact is the basis for the popular belief that all human beings believe in a deity of some sort. Religious activities differ infinitely in detail, but there are indubitable evidences that all human people have commerce with the mystical and the unknown, and perform activities in connection with supernatural forces and powers.

LANGUAGE.—So characteristic of human activity is language that at first glance we might think of it as existing before the dawn of civilization. Yet we must bear in mind that language as intercommunicative behavior presupposes the organization of persons as well as more or less complicated referential situations. People do not speak unless they have something to say. There are projects to discuss, activities to carry on in common; indeed, wherever we have language there is not only a fundamental characteristic, but also a sign of civilization.

LAW.—At one time according to Zulu law, sneezing and clearing one's throat in the king's presence or the exhibition of dry eyes at the death of a member of the royal family were punished by death. The penalty for murder, on the other hand, was an assessment to be paid in the form of cattle. Such law we may regard as peculiarly inept and out of harmony with our sense of justice. This means merely that Zulu law as well as that of other groups different from ours does not fit in with the rest of our culture. In our own nation, however, we find a great tangle of national, state, and municipal laws which often conflict with each other. In some states cousins may marry, in others not. There is at least one state where divorce is forbidden, though all others permit it. But those

states that permit divorces do not allow it upon the same grounds.

Such illustrations as we have indicated reinforce the commonplace that law is an inevitable factor in every collection of human individuals. What we wish to point out is that every human group has its own system of laws, penalties, and methods of legal administration, which somehow serve as instruments of social control.

Customs and Manners.—Many groups incorporate in their religious culture the custom of praying to God to supply them what they need or to help them conquer their enemies. The Druses, however, regard such a custom as an unwarranted interference with the almighty.

Customs and manners may be regarded as the overt behavior equipment of groups. Students of ethnology have gathered together detailed descriptions of all sorts of war dances, religious rituals, domestic customs, and ceremonials of every form from almost every group of people. It is one of the objects of the student of civilization to study these various customs as they exist in human societies and to appreciate their similarities and differences because of historical and current social conditions.

No matter how simple or isolated a group may be, there are always to be found in it innumerable items of food preferences and tastes of all sorts, criteria of propriety and disgust, and conventionalities of speech and every other kind of action. These are generally referred to as mores and taboos. The men of some groups will not eat with their women folk; among others to be struck by a woman is the greatest of calamities. Customs and manners also include all sorts of virtues, vices, and other habitual reactions among the populace that practices them.

Intellectual Equipment.—Finally, every civilizational stock in trade comprises a large inventory of ideas and beliefs which are characteristic features of specific human groups. Broadly speaking, this equipment can be divided into three departments: magic, science, and mythology.

Magical ideas are frequently coupled with practices of various sorts. A Malay will make and burn a wax image of a person he wants to injure. The Zulu chews a piece of wood in order to soften the heart of the cattle seller. A Melanesian will plant a stone with his seeds because the former has the power in it to make the latter grow. The activities mentioned, with all their kin, of which there

are millions distributed in all of the populations on earth, are correlated with assumptions concerning the efficacy of objects and human actions.

Students of civilization are divided in their views with respect to the relationship between magic and science. Certain scholars like Frazer and Tylor regard magic as very closely related to science. The magic of more primitive groups is a simpler form of the science fostered by more advanced societies.

The opponents of this view regard magic as entirely different from science, on the basis primarily that magical beliefs and practices really do not constitute interactions with objective phenomena, but are simply subjective attitudes. There is good reason to believe that while both sides overemphasize certain aspects of the magical situation to the exclusion of others there is considerable relationship between magic and science. This view is supported by the consideration that science among primitive societies is more like the speculative science or the philosophy of complex groups rather than the applied science of the latter, which is closely interwoven with technology.

Mythology has two aspects. On the one hand it connects with speculative attitudes concerning the nature of the world, while on the other it is close to the self expressive reactions of literary art or story telling. It is, of course, the former phase of mythology which fits into the intellectual side of a civilization. There is no human group which does not have a large collection of answers to the questions of how things come into existence and what they are made of, besides explanations for the behavior of the group.

The Evolution of Civilization

Any college student of today is old enough to have observed the evolution of the radio. A somewhat older person may have witnessed the development of the automobile, telephone, telegraph, airplane, and other features of our civilization. Such an evolution must have taken place with respect to civilization in its entirety. As a matter of fact anthropologists and archæologists have worked out what they regard as an authentic series of steps in the evolution of civilization. In this connection they have drawn up a chronology based upon various remains of human activities. This chronology they divide up into the following ages: the eolithic, paleolithic, epipaleolithic, neolithic, bronze, and iron.

Cultural Chart

AGE	EPOCH	PERIOD	HUMAN TYPE	CULTURE		TIME
Quaternary	Recent		Present Day Man	Iron		3,000
				Bronze		5,000
				Full Neolithic		6,000
				Early Neolithic		8,000
				Tardenoisian Azilian	Epipaleolithic	10,000
	Pleistocene	Post-Glacial	Cro-Magnon	Magdalenian Solutrean Aurignacian	Upper Paleolithic	25,000
		Fourth Glacial	Neanderthal	Mousterian	Middle Paleolithic	50,000
		Third Interglacial	?	Asheulean Chellean Pre-Chellean	Lower Paleolithic	100,000
		Third Glacial	Piltdown?			
		Second Interglacial		Eolithic		
		Second Glacial	Heidelberg	Eolithic?		500,000
		First Interglacial				
		First Glacial	Pithecanthropus			1,000,000
Tertiary	Pliocene					

Naturally the actual details of the earlier development of civilizational phenomena are impossible to work out, but in comparatively recent periods conditions are fairly clear. As far as social organization is concerned there is a possibility that the earliest men lived in family organization as units. Fire-making probably goes back to the eolithic period, although definite evidences are available only from the paleolithic age. In the accompanying chart the chronology is indicated in connection with geologic periods and epochs.

Steps in the Development of Civilization

EOLITHIC.—It will be no surprise to the reader that the dawn of civilization dating back a half million years and more yields few remains indicating human development. The evidence that this is the threshold of civilization centers about the eoliths, roughly shaped flint stones which many archeologists believe are not really manufactured instruments, but stones shaped by natural means. These students are of the opinion that these objects are quite like those that are found way back in the tertiary era before man had even evolved. On the other hand, what is called the eolithic period is regarded as the time of Pithecanthropus, Heidelberg, and Piltdown men or half-men who probably did make for themselves tools of various sorts in a simple fashion. It is believed that the earliest step in civilization was a time when the human animal was attempting to refashion his environment in a humble way. He no longer merely picked up a stone to use as a weapon, but tried to shape such stones as he found to fit his purpose. What is regarded as the strongest argument in favor of the view that the eoliths are artifacts is that they must be transitional objects because the first definitely known stone instruments are too perfect to have been made without a previous development.

CHELLEAN.—Archeologists appear to be unable to determine what type of man existed during this and the succeeding period. But they are convinced that the flint implements found give definite evidence of a Chellean civilization. The most prominent of these is the hand pick, or *coup-de-poing*. This is an almond shaped flint which is flaked until at one end a useful point is developed and at the other a cutting or chopping edge, the whole being conveniently shaped for handling. These instruments are dated back to the third interglacial period, about 100,000 years ago. From this time on

archeological records are fairly continuous. It is probably true, too, that between the Eolithic and Chellean there was a transition period, the Pre-Chellean.

ACHEULEAN.—According to De Morgan, Acheulean industry is a specialization of the Chellean. He asserts that the *coup-de-poing* of this period, named from St. Acheul, a suburb of Amiens, is much improved, being lighter and more varied in form. In addition to the almond shaped flints there are also elliptical, rounded, discoid, and lanceolate forms. The elongated lanceolate flint might be a dagger. Accordingly, Acheulean weapons are not only intended for striking, but for cutting as well. There are also hammer and anvil stones and spear heads, in addition to scraping and boring tools.

MOUSTERIAN.—At the time of the peak of the Würm glaciation, which is estimated to have taken place about 50,000 years ago, the Neanderthal man developed his simple civilization over a large area which included North Africa, Asia Minor, and America as well as Europe. Because of the distinctive character of the findings the Mousterian, or Moustierian period as it is sometimes called, because it is named after an archeological station at le Moustier in France, is referred to as the Middle Paleolithic.

The Mousterian industry shows a number of improvements over previous periods. In the first place, instead of using merely the nucleus of a stone from which pieces are chipped away, the men of this period make use of the flake that is split off the original stone. This makes for a finer tool. Again, the flakes taken from the core of the stone are retouched. This means that fine chips are worked off the flake by pressure. The Mousterian armament is somewhat more complicated, comprising notched blades of various sorts, and Obermaier believes that some of the Mousterian hand axes were probably hafted. Some archeologists claim that in this period are also found the beginnings of the bone implement technology. According to Mousterian records there is likewise a development of definite sorts of burial customs. The use of fire is another trait of this civilization.

AURIGNACIAN.—Because archeologists are tremendously impressed with the great civilizational development of the Aurignacian period (about 25,000 years ago) they call it the beginning of the

Upper Paleolithic. This is the age of the Cro-Magnon man. Civilization now becomes rather elaborate. There are new flint tools and instruments, planing and engraving tools made for work on hard substances.

The beginning of an effective bone and horn industry is another characteristic. From these materials the Aurignacians fashioned all sorts of tools, awls, polishers, and tubes for holding paint. The archeological findings also include skillfully made harpoons.

Evidences are available that the Aurignacians developed elaborate burial customs. It is possible that they painted the bodies of the dead. Some authorities believe that the placing of ornaments, weapons, and food objects with the dead argues that the Cro-Magnons had some ideas concerning survival after death.

Probably the most striking developments of this period are found in the field of art. Aurignacian man decorated his caves and caverns with animal drawings of various sorts, such as the mammoth, rhinoceros, horse, and deer. They also produced creditable bits of sculpture including figures of the human form.

Solutrean.—Here again there is a civilizational advance over previous periods. In fact, the Solutrean epoch marks the culmination of flint working. The stone tools and instruments found heretofore are at this period developed with great efficiency. De Morgan states that the flake basis is sometimes chipped on one side for drills, saws, etc., while the javelins, spears, and daggers are worked on both sides. In general the Solutrean workers had developed a fine flint technique. Osborn points to the barbed dart as the chief invention of the men of this age.

Bone instruments also have made progress as indicated by the finding of bone needles with eyes, probably used for sewing garments. Animal teeth were drilled for stringing, no doubt to carry out ideas of personal adornment.

Solutrean men produced many works of art, though Osborn does not think their work is as rich as that of the Aurignacian period. Besides engravings of animals on their tools and weapons they worked out various types of human figurines.

Magdalenian.—This stage of development is regarded as marking the climax of the Paleolithic period. As far as stone work is concerned there appears to be either a retrogression or a great advance. On the one hand, the retouching work of earlier periods

has degenerated, but on the other, the Magdalenian can split off by one blow long, straight, thin flakes that are especially suitable for cutting tools or knives. The bone industry shows striking development. All kinds of tools are fashioned from this material as well as sound making instruments such as whistles and flutes.

Concerning the identity of Magdalenian man, doctors seriously disagree. Most paleontologists accept the view that he was Mongolian of the Eskimo type rather than of the European white family. But other students emphatically reject this idea, claiming that Magdalenian man was Caucasoid. Still others take the compromising stand that though he was not Mongoloid, he had Mongoloid elements in his make-up.

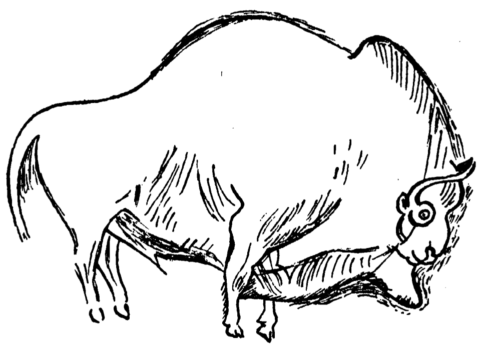


Fig. 106—Bison outline drawing from cave at Font-de-Gaume, France. From Osborn (after Breuil), *Men of the Old Stone Age,* Scribners, publishers.

Another unsolved problem of civilizational development is how the people of this period could produce such marvelous paintings and drawings as are found for example in the caves of Altimira (Spain), Font-de-Gaume (France), and other places. Some of these are illustrated in Figs. 106 and 107. No less than thirty forms of animals are depicted in this cave art. This work surpasses anything found among primitive people of modern times. Not only did these people have a keen sense of line and symmetry, but they also understood colors and the use of various shading devices.

In the field of sculpture, too, Magdalenian art reaches high points. There are fine animal types carved in bone and ivory, examples of which are shown in Figs. 108, 109, and 110. Magda-

lenian sculptors also produced artistic reproductions of the human figure.

EPIPALEOLITHIC.—This period is presumed to mark a great transition between the paleolithic and neolithic cultures. It is divided off into definite sub-periods, one of which is the Azilian, named after a station located at Mas d'Azil about forty miles from Toulouse in France, and another, the Tardenoisian, so termed be-

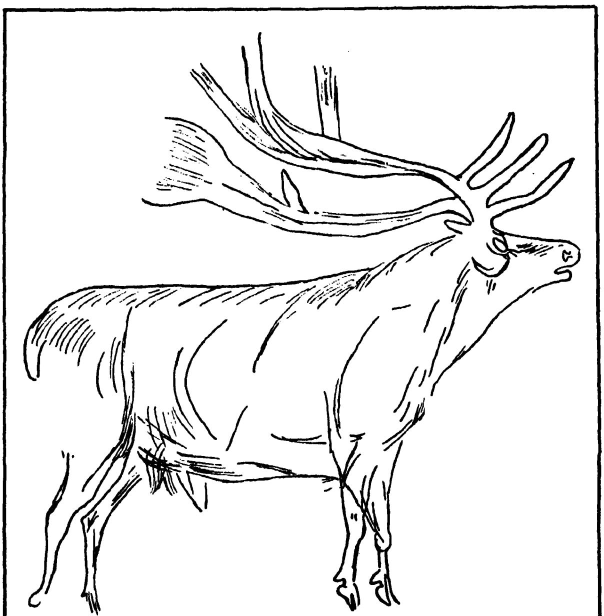


Fig. 107—Royal stag engraved on ceiling of cave at Altamira, Spain. From Osborn (after Breuil), *Men of the Old Stone Age,* Scribners, publishers.

cause of a station called Fère-en-Tardenois, also located in France. There are several others. According to Osborn, the artistic spirit of the people of this time has entirely disappeared, since there are no traces of animal engravings or sculptures. The only paintings found are primitive patterns in red produced on flattened pebbles, and geometric designs on wall surfaces. The flint and bone industries also show marked retrogression. But all this apparent degeneration only indicates the transition to a higher form of industry,

for in this period are found the beginnings of tools of polished stone.

NEOLITHIC.—When we come to the Neolithic period, civilization has made a tremendous step forward. One of the fundamental characteristics of Neolithic civilization is the development of stone polishing. The working of flint by fracturing which reached a high stage in the previous period is now added to by the finer grinding

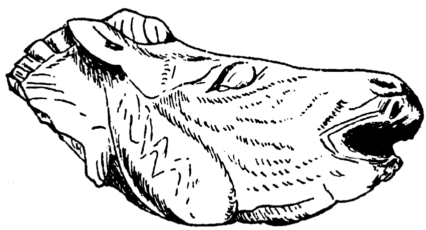


Fig. 108—Horse's head sculptured on a reindeer antler belonging to Magdalenian layer of Mas d' Azil. From Osborn (after Piette), *Men of the Old Stone Age,* Scribners, publishers.

techniques of Neolithic stone workers. They could now make use of the hardest stone materials. The higher form of workmanship came as a gradual development, since in the earlier Neolithic period chipping was still practiced. The grinding and polishing of stone marks the arrival of the full Neolithic age.

Neolithic technology evolved an instrument which was a great improvement over the hand or fist pick of the paleolithic period, and over the horn ax. This was the hewn stone ax, with which Neolithic man could hollow out tree trunks to make boats, and fashion beams with which to build permanent dwellings. The lake dwellers of Switzerland needed many piles as foundations for their houses.

As the records of ethnology indicate, the Neolithic age is characterized by a whole series of new civilizational traits. For example, this is the age of pottery and the bow. With the development of these articles the entire mode of human life is changed. Domestic economy becomes greatly enlarged and more complex, for many new kinds of food can now be utilized because of the use the bow affords for killing birds, rabbits, and other mammals, and even larger game. Pottery provides the means of cooking food, and this was a great advantage in the utilization of the type of food that

could not be eaten raw. The use of pottery goes along with the cultivation of cereals. Neolithic man therefore becomes a planter in addition to being a hunter. He cultivates barley, wheat, millet, peas, and other plants.

Other traits of the full Neolithic period include the domestication of animals, notably cattle, swine, sheep, and goats. The dog, too, is now a part of man's cultural equipment, but this animal is believed to have attached itself to man in symbiotic fashion and not to have been actually domesticated.

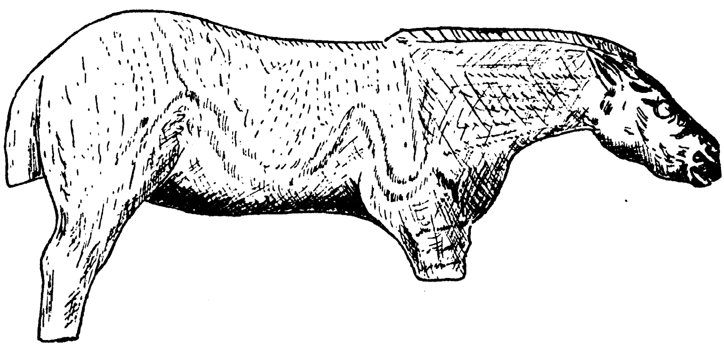


Fig. 109—Ivory carving from grotto of Les Espelugues, Lourdes. From Osborn (after Piette), *Men of the Old Stone Age,* Scribners, publishers.

Neolithic man also began to spin and weave cloth for clothing. His agriculture therefore includes the cultivation of flax. The art of the time extends to the decoration of pottery and other utilitarian objects. The designs used are very elaborate, especially in Asia and North Africa.

Knowledge of every day life in Neolithic times in Europe is derived principally from the findings recovered from the mud where the Swiss lake dwellers lived, and from the kitchen middens or refuse heaps of Denmark. Scientific curiosity concerning burial rites and religious beliefs of this time is more or less satisfied by a study of the bone caves and monuments. Some archaeologists believe that elaborate burials imply a respect for the dead, motivated by a belief in an after-life. However this may be, Neolithic man erected elaborate stone monuments. These megalithic structures consisted of (1) large single stones set up, called menhirs, (2) series of such stones aligned in rows, and (3) tombs consisting of

"dolmens"—large slabs set over vertically erected stones, and (4) "passage and gallery" structures.

AGE OF BRONZE.—When our brief sketch of the developmental steps of civilization reaches the bronze age it breaks down of its own weight. Civilization has now become too inordinately complex even to mention the most outstanding features. At this period

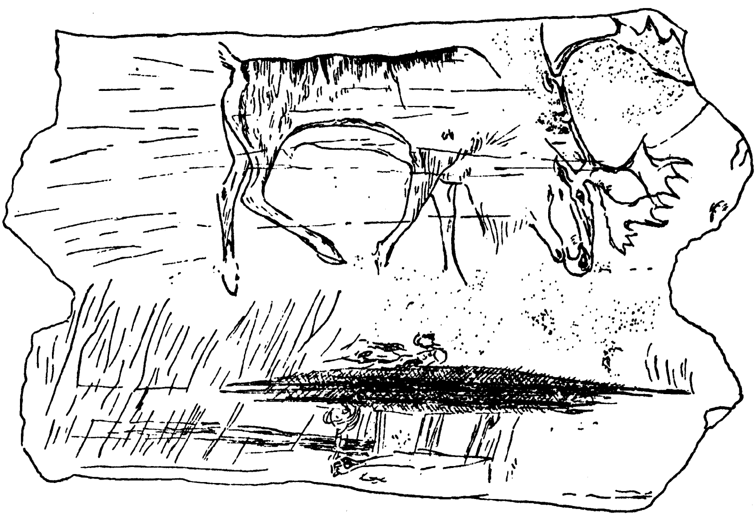


Fig. 110—Reindeer engraved around a piece of reindeer antler from Kesserloch, Switzerland. From Osborn (after Hein), *Men of the Old Stone Age,* Scribners, publishers.

the material equipment of human groups and their activities come pretty close to the prehistoric dawn of our present civilization. We must note, however, that just as the development in the stone ages is a gradual one, so here the transition from the stone epoch to the metal period is made by slow degrees. Within the Bronze age, too, a series of gradual changes may be traced. The full fledged bronze period is preceded by one in which copper alone is used, while the secret of amalgamating soft copper with tin, which gives strength and hardness to the metal, is being evolved.

The use of bronze marks the evolution of all sorts of new civilizational factors in important centers such as Egypt and Babylonia. Kroeber draws up a list which includes writing, sunburned brick, stone masonry, sculpture, architecture (comprising the arch),

the potters' wheel, astronomical records and calendars, and an elaborate cult of the dead.

IRON AGE.—Even greater civilizational strides than those which came about when copper and tin were amalgamated in the early metal age occurred when iron was tempered to make steel. It would be a fascinating story to trace out the development of our present machine age with its gigantic dynamos, locomotives, bridges, and skyscraper frames from the earliest use of iron about 3,000 years ago. Such a story would probably begin with the people of Western Asia, who may have first begun to work iron as a civilizational improvement over the copper and tin metals. When the superiority of iron to bronze first became known, the potentiality for developing a more complex technology was ready at hand. Whether the iron technology was responsible for a general impetus in cultural development is not very easy to say. Civilization or culture is too complex a phenomenon for one factor to be the cause of the development of all the rest. We cannot overlook either that the technology of a culture is very different from its customs, laws, and manners.

But since this engrossing story cannot be told here, we must content ourselves with the suggestion that today we have already passed out of the age of iron and steel. It is not these things that characterize our civilization. Ours is an age of chemistry, say some; an age of electricity, say others; while another group speaks just as loudly for general science. At the same time there are those who raise the cry that we cannot live by technology alone, and that as far as art and social organization are concerned we have not advanced far beyond the Egyptians and Greeks.

Is Evolution Unilinear?

Throughout our brief sketch of cultural evolution we have traced a straight line from the Eoliths to electricity. The question arises, is this how things actually happened? We can only answer that since in the earliest prehistoric periods of human development findings and other evidences are so meagre, we cannot but accept this story as true. Or at least we can say that such a single-dimensional theory is of great service. However, when this hypothesis is applied to historical or current civilizations it is of

doubtful value. This is true, as a matter of fact, of the nearest prehistoric periods also.

There is a familiar theory that men began life on earth as savages—that is to say, as hunters—then became in turn barbarians or pastoral nomads, and only after settling down to an agricultural and industrial life did they finally turn civilized. The increase of knowledge concerning human phenomena does not bear out this kind of theory. Nor is it true that so-called civilized men have passed through simpler types of civilization such as are found on the earth today. It seems entirely erroneous to believe that so-called primitive men are evolving toward the particular kind of civilization that the Europeans have achieved. There is good reason to believe that the civilizations termed primitive are as old and as far evolved as our own. They evolved differently, that is all.

The danger that lurks in the uncritical use of a unilinear evolutionary theory is illustrated by the abortive attempt to fit all living types of men into a simple hierarchy. It is a common but fallacious notion that it is possible to trace among living men a series of stages of evolution. As it happens, whoever posits such an evolution generally puts his own type of human being at the top of the scale. White men put the white type of man at the apex of this evolution, whereas black men do the same for their group. This situation suggests at once that a rational attitude calls for the study of available facts on their own merits. Accordingly we find, for example, that certain characterisics of a civilization place it higher in the scale from the standpoint of a certain arbitrary standard, whereas similar concrete facts enable us to put other people at a still higher point. This applies even to so-called primitive peoples.

In such a problem as this we no doubt can profit by observing changes going on in civilizations. For example, we find that feudal nations like Japan become more or less democratic at one stroke without passing through the intermediate stages found in the history of other nations. The rapid and almost complete transformation of Russian society from an agricultural to an industrial civilization, without the transitional handicraft steps that the English and German groups passed through, illustrates the same point.

Origin and Distribution of Civilization

It may seem like a perversity that Englishmen and other Europeans must have Virginia tobacco, whereas the American will smoke

it only out of necessity. The well-to-do American prefers Turkish tobacco. As a matter of fact, while tobacco was first used in America where it is native, it has now been carried to every part of the earth. The ethnologist traces the origin of our alphabet, whether we use the Roman, Greek, or Sanskrit form, to the Phoenician original which was invented somewhere at the Eastern end of the Mediterranean basin. The Roman arch, so effectively employed in American architecture, is traced back to the Etruscans from whom the Romans borrowed it. The Etruscans, in turn, are believed to have derived it from the Babylonians. Similarly, anthropologists report that the story of the Magic Flight—that is to say, the tale in which an individual is running toward some goal while various obstacles are put into his path—is found in widely distributed districts of the world.

These are only a few of the great number of civilizational elements that are very widely distributed over large civilizational areas. Now the question arises, what are the processes whereby this dispersion comes about? Anthropologists are divided into many schools of thought with respect to this problem.

THE DIFFUSION THEORY.—G. Elliot Smith and his pupils have taken the extreme position that the fundamental process of human culture distribution is borrowing or diffusion. In detail the members of this school believe that Egypt is the primary center of all civilizational elements. It is from thence they declare that all cultural factors have been carried to the rest of the world. A striking illustration of their position is their insistence that the civilization of the Maya Indians, which comprises megalithic monuments of all sorts, including pyramids, is derived from Egypt. They claim an Egyptian origin also for the characteristic stone carvings of the Indians of the Western hemisphere.

Although the opponents of the diffusionistic school declare that the pre-Columbian civilization, which includes the Maya development, could not possibly have originated in Africa, there is no question at all but that diffusion or borrowing is a very fundamental process in civilization. It was undoubtedly by this means that many cultural elements have become distributed. This is true of the spread of tobacco, the alphabet, the arch, and a great host of other such civilizational traits.

It is very difficult, however, to explain other distributions on this basis. For example, there is the phenomenon of Couvade, a

custom according to which when a woman gives birth to a child she proceeds at once to her customary duties, whereas the husband takes to his bed with characteristic ceremonials. This custom was practiced among the Basques of France and Spain, and also among the Indians of Brazil. How could this trait have gone from one place to another?

Another very striking instance of civilizational distribution is the development of the mathematical conception of zero among the Maya people of Mexico and the Hindus. While the symbols representing the concept are very different, both peoples have harbored this important and complicated civilizational trait.

No less surprising is the existence of a musical instrument called the panpipe among both the Indians of Brazil and Peru, and the Melanesians of the Solomon Islands. The remarkable thing here is that we should find among such widely distributed peoples instruments that agree in structure, scale, and pitch. Of the many similar startling examples of civilizational distribution we have space to mention only the identical patterns in basket work and other decorations used by widely separated peoples.

THE CONVERGENCE THEORY.—Because of these striking cultural distributions the theory has been advanced that these similar civilizational elements have not been carried from one group to another, but have originated independently in the places they are found.

It is unfortunate for the convergence or independent origin theory that we cannot see these traits develop. It is for this reason that certain anthropologists assert that the problem of diffusion versus independent origin is a purely academic one.

Nevertheless it is an advantage to the theory that it is impossible for cultural traits to be carried over distances across which people cannot migrate. Furthermore, as we shall presently see, considerable light may be thrown indirectly upon the problem by the psychologist.

Psychological Implications of Cultural Distribution

It is not surprising that different psychological theories underlie the diffusion and the independent origin doctrines. The extreme diffusionist builds his theory upon a postulate that there are ultimate differences in mental capacity between different people. On

this basis, only the Egyptians were capable of originating civilizational traits, and if other groups of people possess them it is because they have somehow derived them from the original Egyptians. It is hardly necessary to add that such a theory has no scientific basis. Mentality is not a kind of force or potentiality that brings things into existence. On the other hand, it is hardly likely that we are bound to conclude that all of the invention we observe occurring today is unreal, that we are only developing things we derived from the Egyptians. Again, it is impossible to say that the mentality which develops these inventions is Egyptian in origin. Furthermore, the Egyptians themselves must have had an origin and it might be argued that the people who gave rise to the Egyptians also gave rise to other kinds of groups.

The convergenists, on the other hand, postulate a psychic unity. In other words, they assume that mentality is the same all over the world and that therefore all people are capable of inventing things. Such a view is no more satisfactory than the other because it, too, makes mentality a kind of power which causes things to come into existence. We suggest, therefore, that the phenomena of distribution can probably best be handled on the supposition that cultural traits have developed on the basis of a definite interaction of individuals with certain materials and conditions such that all sorts of civilizational distributions are possible. In short, given similar interactional conditions, similar inventions are very likely to occur.

Processes of Civilizational Distribution

Original Dispersion.—We may suppose that the universal possession of certain general traits, such as language, social organization, etc., can be accounted for by the original dispersion of man from a common source. In other words, we propose that there is such a thing as a cradle of civilization, that human animals developed to a certain stage and then became dispersed, carrying with them various common civilizational characteristics. While this process throws light on the possession of language, it does not, of course, account for the particular kind of language, and so on throughout the whole list of civilizational characteristics.

Original Development.—If it has been possible for human beings to develop civilization, as everyone must believe, then the same process could take place in localized groups in different places

on the earth as well as some central home. Such being the case, we should expect that while all of these groups would have languages they would differ in detail. Furthermore, some of these civilizational traits developed by the local groups might very well be similar. If it is assumed that the human animal can invent different things there is no reason to suppose he cannot invent the same things, providing of course that conditions are very similar. It is this principle which operates when different workers claim to have developed the same invention inside of a local group. It should not tax our imagination too much to find correspondences between the general conditions of far away groups and between different conditions in the same nation.

INTERRELATIONSHIP BETWEEN GROUPS.—Another set of developmental processes can be observed to operate in the distribution of cultural elements when groups interact. In the first place, we may have sets of persons from one civilizational center migrating to another, carrying with them various objects which influence the new group in which they live, or perhaps become modified and exist in a new form. This sort of civilizational influence of one group upon another is also illustrated by the case in which one group conquers another or in some way proselytizes some group to its own way of thinking and acting.

Again, there is nothing so obvious as the interchange of traits between groups who remain in their own original location. Here we have all sorts of migration of traits in the form of borrowing, such as the carrying over of tobacco by Sir Walter Raleigh to England.

When we consider the phenomenon of trait distribution in this objective way we can do justice to the facts of both diffusion and convergence. Moreover, we need not resort to any absolute process or any unjustifiable theory concerning the nature of human mind.

How is Civilization Explained?

Two warring tendencies characterize scientific work. On the one side is an inevitable curiosity more or less free from entangling presuppositions, while on the other is the constant attempt to explain things simply and at one fell swoop. Nowhere do these rival tendencies show up so much as in the study of human happenings. Many a piece of anthropological work is ruined by the attempt to find a simple explanation for a complicated phenomenon.

We have already seen how the different problems of cultural distribution are explained by saying that cultural similarities are the result of exclusive superior mentality or of common mentality. Another familiar instance of this tendency is to account for the characteristics of a civilization by the environment. For example, it is said that the high development of Greek civilization was due to the topography and location of the country, to which the apt reply has been made that the same environment has existed during the Turkish occupation and since, but the Greek civilization has gone. Similarly, climate is invoked as an all powerful agency in the development of cultural characteristics. Another such omnipotent causative element is the race factor. Race seems to be looked upon as a sort of fertilized ovum which will inevitably develop a certain type of civilization.

Now it must be emphasized that no serious scholar who has presented one or another of these causative factors has failed to discover relevant evidences of the truth of his doctrine. All of these factors except race no doubt play a part as causal agencies in making a civilization what it is, but the great fallacy here is to regard these partial contributing agencies as exclusive causes.

On the contrary we propose that if we are to explain the nature and development of a group and its civilization, we must courageously face the probability that a tremendously large number of factors always cooperate in the production of a particular kind of civilizational result.

Does climate influence civilization? It is impossible to deny that the fur garments of the Eskimo constitute a genuine adaptation to the rigors of the Arctic. Furthermore there is no question but that the indolence of tropical people and the general simplicity of their civilization are greatly influenced by the climatic conditions under which they live.

The Indians of the Northwest coast have developed a remarkable wood industry, and as it happens, the environment of these people includes a very complicated forestry. It is easy therefore to conclude that this wood working civilization is a direct effect of the kind of environment in which the people live. It turns out, however, that the Indians of California, who are surrounded by just as favorable a tree environment, have not developed this wood working industry. Undoubtedly the existence of certain environmental conditions makes possible the development of certain traits of civ-

ilization, but it does not explain why those traits exist. Similarly the snow houses of the Eskimos as cultural traits are accounted for by the influence upon them of the snow environment. But the Chukchees of northeastern Siberia who live just across Bering Strait are not influenced by this type of environment. Instead of snow houses they build crude tents of hide, which they stretch over heavy wooden frames, and laboriously drag such houses with them.

Such illustrations as we have just been citing suggest to the anthropologist that there is another factor that operates—namely, cultural trends. Once a given people develop a trend of this sort it persists and operates despite the climate or environment, and notwithstanding all the disadvantages that such trends occasion in the life of the people concerned. A familiar illustration of such a trend is the general character of a language. For example, in spite of all the changes in the English tongue there are certain characteristics that have always marked this mode of speech.

We must not overlook, either, the effect of historical conditions on the culture of a group. By historical conditions we mean the various political and social interactions of groups. Through such contacts various modifications are introduced into the interacting civilizations which reflect upon the character of both forms of culture. Similar causative agencies are also found in the particular life conditions of a single group. It may be the poverty of a collectivity which is responsible for the development of a particular kind of marriage custom. Human conditions of all sorts, such as the exigencies of commerce and increasing population, may bring about wars. Incidentally, customs are varied and changed; inventive capacities are stimulated, to the end that the whole culture is modified.

Social institutions of all sorts must be counted as determiners of civilization. It is a familiar fact that the kind of religious institutions found in a group has a tremendous effect upon its other civilizational factors. The religious life of a community introduces all sorts of taboos and other inhibiting institutions which make for the conservation of certain traits. On the other hand, the various institutions connected with dress hasten changes, all of which combine to make a civilization what it is.

Not to be forgotten either are the psychological influences upon civilization. The intrigues of men and women desirous of wealth and power have always played tremendous parts for the weal and

woe of a society. It is such desires and aspirations which have often been responsible for national policies and wars between nations, with the consequence that the civilizational conditions of the groups concerned have become modified. For the student of history such names as Maintenon, de Pompadour, Essex, Buckingham, Rasputin serve as sufficient stimuli to recall the sorts of psychological influences that we are pointing out.

In brief, we must always look for many factors instead of a few in attempting to account for any sort of civilizational conditions; in addition we must appreciate the thorough interrelationship between these numerous factors. Such causal conditions are abstracted from a concrete situation. In other words, there is no such thing as pure environment, or purely psychological or institutional factors. These are all phenomena which themselves derive their character from interrelation with other factors.

The Rise and Decline of Civilization

For the most part history is treated as the diary of a nation. The historian works on the assumption that he is dealing with a unique entity. And so he records the chronicles of a nation as though he were considering the activities and relations of a person. There is a possibility that this represents the continuation of a tradition begun when a society or a nation was identified with the ruler thereof.

Civilizations, like nations and dynasties, have their rises and falls, but since civilizations are not single entities nothing happens to them as single units. Cultural happenings must be studied as specific details. The Babylonian civilization has disappeared, but the arch which was its distinctive architectural feature remains. Babylonia still lives in the most recent astronomical calculation because of its use of the 360° circle. Where is Phoenicia today? It is gone; yet as we have seen we use its alphabet, and we scarcely know how many other of its cultural elements. The same can be said for Greece. While the political unit no longer exists, Greek philosophy and art still survive, and in a very energetic way, too.

When we study the details of civilizations we find that in any existing culture, progress is made in one sort of trait, while regress occurs in another; at the same time other traits change without moving in any special direction. It is frequently pointed out that

in our own civilization there is a great contrast between the striking progress made in technology, while the traits of morality and social justice remain at a positive standstill. No one can gainsay that the development of mechanical processes in the industry and transportation of today is anything short of phenomenal. It is probably true that never before in the history of the world have there been such tremendous strides in mechanical invention. Think only of the complicated electrical developments and the evolution of airplanes, radios, etc. But can we point to analogous improvements in our human relations and techniques of social organization?

Those who admire the magnificent achievements represented by the stained glass of Chartres and Saint Chapelle deplore the loss of the capacity to produce such artistic works. There are innumerable records of lost arts. Those even within the historical period represent distinct degenerations and disappearance of cultural elements. Curiously enough, some of these losses are associated with what are called progress. A prominent metropolitan newspaper publishes a special edition of its journal on durable paper for library files. This is because the great circulation of papers and their size have made it necessary to make paper which in no sense is like the products of the old handicraft industry. Many librarians are of the opinion that books published a century ago will remain on the shelves, while those published in recent decades will disappear because the greater dissemination of books has made necessary the employment of inferior materials.

Among the other changes that take place in civilizational elements we may instance the divergence of factors which derive from a common source. One of the best illustrations is the way the English and German languages have become increasingly different despite the fact that they are offshoots of a common language. A change operating in the opposite direction is the way diverse cultural elements become more and more alike to constitute units of a single cultural system. The process here is the standarization of various cultural elements of a community until they tend to center about a mean or average. A striking case is the way a philosophy or a system of thought takes on the characteristics of a social organization. In an agricultural, religious community philosophy becomes idealistic; in an industrialistic and commercial civilization philosophy assumes a pragmatic or crudely realistic aspect.

Whenever we are unable to trace the direction in which a change is progressing we may speak of it as unqualified change. Thus fashions keep constantly altering, but no one can say whither they tend. Moreover, it is noticeable that unqualified change operates in cycles. There is a constant recurrence of the same kinds of conditions.

Superiorities and Inferiorities in Civilization

The openminded observer does not regard the word civilization as a union-card of human distinction. But even when such a person agrees that civilization means human life with all its diverse forms of organization and equipment, it is still difficult for him not to believe in clear cut superiorities and inferiorities among different civilizations. This is because such a person is himself a member of some specific form of society. This fact colors the views of us all.

Being Christians, then naturally we are infinitely superior to heathens. If we belong to a republican society we cannot but look with contempt upon the Fascistic declaration that personal liberty is a fraudulent conception. Our society being capitalistic we tend to look upon communists as slighter specimens of humanity. Having the kind of social life we do, we are stirred to violent, moral indignation to read what goes on in India. These instances are sufficient to suggest one of the inevitable consequences of civilizational diversity.

Now let us inquire whether it is really possible to compare civilizations, when we use our own as the criterion of excellence. No doubt to begin in this way is to declare our inability to judge.

When we take a detached attitude toward different cultural systems we might use as a basis for comparison the criterion of adaptability. But here, too, the inevitable result is that we discover that each particular type of civilization is best adapted for the people possessing it and the conditions under which it is found. From this standpoint, then, it is impossible to utter a judgment of superiority concerning any two civilizations.

Yet if we must evaluate civilizations there is still left us a principle of great value—namely, we must in all cases pay due regard to specific phenomena. This means that we might conclude that a certain group has developed a superior technology to some other,

or perhaps we must even consider particular tools or industrial processes. Again, one group may have done more in the way of art or some particular art. The Arabs have not developed pictorial art, though they have excelled in fine architecture. By considering specific cultural factors or elements in this way we can avoid treating tremendously complex civilizational systems as simple units with the usually fatal result of losing our critical attitude.

Man and Civilization

There are students of philosophy who declare that all philosophical systems are variants of the two fundamental viewpoints of Plato and Aristotle. In the former tradition are found all the idealistic systems, in the latter all the different types of realism. In the general field of human events we find those scholars who look upon Pericles, Alexander, Mohammed, Genghis Khan, Napoleon, Bismarck, and Lenin as the makers of history. It is such people as these, say the hero worshippers, who have made the world what it is. It is not merely the uninitiated, but the academic historian, who has execrated the last German emperor as the evil genius who made a war and brought about the destruction and misery which is even now engulfing us all.

On the other hand, there are those who regard intellectual geniuses merely as spokesmen of their times. Philosophers are great because their ears are sensitive to the whisperings of their age and their voices loud enough to express the thoughts of their era. Heroes are instruments for the execution of the orders which each period dictates.

Such views have become formulated in opposing theories concerning the relation of man and civilization or society. According to one theory, mind is the all powerful factor in human affairs. Mind is a directive agent for all that happens. For this reason man is regarded as an important element in civilization; in fact, the latter is considered as dependent upon the individual.

In support of this theory it is pointed out that inventions are the work of persons. It is undeniable, of course, that everything in the way of civilizational objects and techniques must be conceived and worked out. In our complex civilization there is an Edison, a Marconi, a Langley, the Wright brothers, a Bell, a Diesel, a Nobel, and a Westinghouse. This abbreviated roll and its lengthened pro-

totype in the mechanical field can, of course, be duplicated in the world of science, medicine, painting, sculpture, and so on throughout the series.

On the other side is the theory of social destiny. This doctrine maintains that in history as in human affairs generally, the individual, no matter who he is, is carried on by a stream which no man can control or stop. What man has made a language or created a society, invented a religion or constructed a set of laws?

This theory rests upon the fact that no man can think of anything absolutely new. Mohammed combined Christian and Jewish doctrine with primitive Arabic material. Inventions are always claimed by several workers and in general grow up gradually out of older civilizational elements. The argument is doubtless as cogent and significant as that on the other side.

The perennial peacemaker appears here as elsewhere. He brings with him a theory of the "organic whole," and points out that man is inevitably a member of a society or a civilization, but on the other hand, societies and civilizations are made up of individuals. For the most part, this is a combining theory which attempts to bring together the two sets of views and their supporting facts. Perhaps the mediating position is not very satisfactory after all. For like the other two it starts with the faulty abstraction that society is one thing and man quite another, even though they do constantly interact. Man is supposed to be a source of innate mental powers that are brought out by society, after which they in turn operate upon society itself.

Here once more we must invoke the principle of specificity. Broad generalizations must be inhibited. Human occurrences must be studied as particular happenings. When we study the relation of the individual and society we should not start with any conception of an abstract, simple society nor with an abstract individual, but rather with a set of concrete situations.

From certain standpoints it is quite convincing that the individual is submerged by society. For example, it is true that an individual exclusively bred in Germany must inevitably speak German. Moreover, every individual has imposed upon him a series of concept patterns. When students of literature emerge from their classrooms they inevitably think in terms of romanticism, classicism, realism, etc. Students of psychology find their thoughts cast in the form of behaviorism, mentalism, and the like. But let us

not overlook the fact that every language is an exceedingly complicated phenomenon. Think only of the great number of words, pronunciations, and colloquial expressions. Similarly, the pattern of one's thinking is also conditioned by the specific details of one's own upbringing and experiences; every person interacts with so many things and individuals, with such a mutual give and take, that the idea of the inevitable submergence of the individual is a highly imperfect one. We cannot but conclude that there is no such thing as a social entity which drowns out the individual in this crude form.

On the other side, there is no such thing as an individual, representing a unique and independent entity operating upon society or civilization. There is no such thing as ultimate mentality. The intellectual and other equipments of the individual are gradually developed as modes of adaptation to all kinds of stimulus objects, persons, and conditions. It is impossible, then, to think of a person who overrides society or molds it to his will. The activities of an inventor, a military leader, or a statesman must be considered from the standpoint of the actual effects they have, effects which are certainly not inconsiderable. When we think this way we are not led to any crass conception of the domination of man or civilization.

To envisage effectively the relationship between individuals and societies or civilizations, one must also take into account a tremendous series of specific conditions and events such as economic happenings, social organization, migrations, and political events, in the way we have suggested when discussing the causes of social happenings. To do so gives us a rational conception of how psychological phenomena interplay with other kinds of human conditions and events in actual, human situations.

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